THE MARINE REVIEW

VOL. 37. CLEVELAND, JUNE 4, 1908. NEW YORK No. 23

A New System of Ship Construction*

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Of late years considerable advance has been made in ship construction. Lower tiers of beams and decks have been dispensed with that were not long ago considered essential for structural strength. New types of vessels, such as the turret steamers of Messrs. Doxford, trunk steamers of Messrs. Ropner, and cantilever frame vessels of Messrs. Dixon, have also been built and proved to be successful, both structurally and commercially, yet the fundamental principles on which these and ordinary vessels are now being constructed are the same as were adopted in the earliest days of sea-going vessels.

So far all merchant vessels have been built with closely spaced transverse frames and closely spaced transverse beams, with the exception of one or two vessels built by Scott Russell in the 60's with longitudinal framing, full particulars of which will be found in Scott Russell's works. The Great Eastern, built on the box unit system, was of course the most notable example, and, being so well known, it is unnecessary to analyze the structure for the purpose of this paper. The difficulty and cost of erection were probably such as to prevent the system being generally adopted.

Naval architects have for so long recognized the great increase in strength obtained by framing a vessel longitudinally, that it is a matter for wonder that some practicable system of longitudinal framing has not been arrived at, or hitherto suggested, the advantages being so clear and so desirable.

In the new method of construction with which my name is associated, the closely spaced transverse frames and closely spaced transverse beams with which we are so familiar, are omitted. The transverse strength of the vessel is obtained by fitting directly on the plating a series of strong transverse girder frames and beams at widely spaced intervals, or where transverse bulkheads are fitted for the purpose of subdivision, as in oil steamers, for instance, they take the place of such transverses, but it is not essential that bulkheads should be fitted for obtaining the requisite structural strength. The transverse structures, which extend, where practicable, completely round the vessel, are of sufficient strength to withstand the whole collective water pressure on the skin of the vessel, and the upper portions forming the transverse beams are of such strength as to be able to carry the same collective weight on the deck as the greater number of transverse beams fitted in vessels of the ordinary construction.

*Read at Institution of Naval Architects.

Fig. 1.

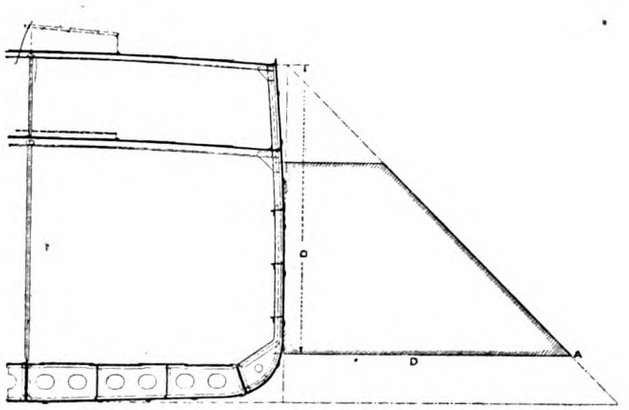
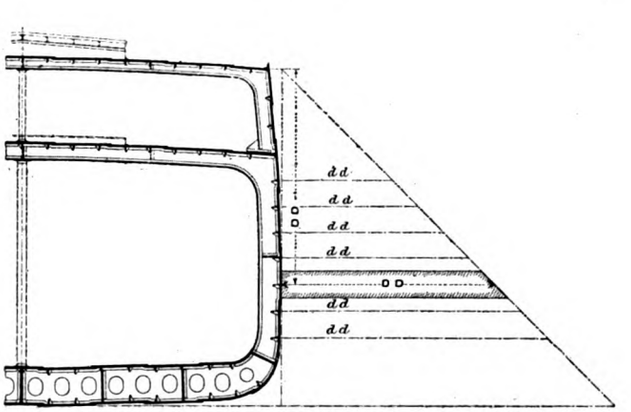


Fig. 2



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It will be observed, from the diagrams, that the transverses are in all cases directly attached to the shell plating and deck of the vessel, and this is of the utmost importance as it enables the shell plating and deck plating, with the efficient longitudinal support which will be described later, to be considered as part of the transverse girder when calculating the comparative stresses.

The transverse thrust is also borne in mind when determining the arrangement and scantlings of the materials forming the transverse girder beams.

Having now briefly indicated how the main transverse strength of the vessel is provided, the arrangement of longitudinal stiffening is next to be considered. The shell plating and deck between the transverses are supported by continuous longitudinals, the transverses being slotted to admit of the longitudinals passing through them. The longitudinals are dealt with as girders having a length corresponding to the interval between the strong transverses, and are of strength not less than that of transverse frames of vessels of the ordinary construction, the comparative stresses being taken for each calculation under the same conditions as to water pressure, etc.

The longitudinal beams are similarly considered, but a deck load is taken as a basis; those at the uppermost deck are increased beyond the size required to give a corresponding stress on ordinary transverse beams on account of the longitudinals being also subject to longitudinal bending strains. Whether this increase is necessary or not in considering material of stiffening which is not already unduly stressed, and which at the same time is relieving the plating, is a matter for discussion.

In vessels with double bottoms, the stiffening, whether in the nature of plates, angles, or of sectional material, is also fitted longitudinally, but a transverse floor is fitted in line with the side transverses, and where the spacing of the transverses is great, an intermediate transverse floor, either intercostal or continuous, should be fitted in the bottom in order to provide for sufficient transverse strength for docking purposes and to efficiently support the longitudinal stiffening in the bottom.

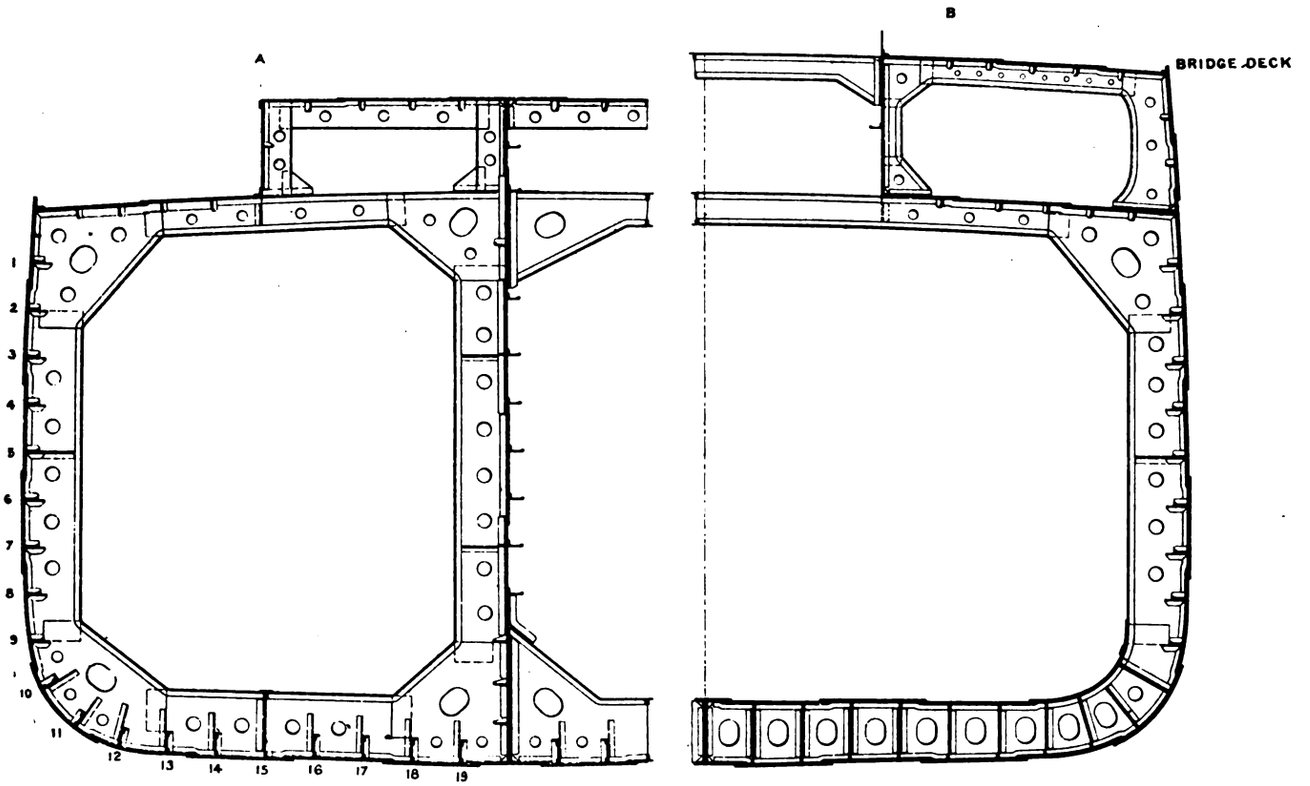
It will be apparent that the arrangement of material provides for increased longitudinal strength, and admits of the shell plating and deck plating, when of substantial thickness, being reduced below the recognized standards of the various classification societies. It would appear that a vessel so constructed could safely withstand higher longitudinal stresses than a similar vessel framed in the ordinary manner by reason of all the plating being supported in the direction in which the greatest stresses occur. This consideration is in strong contrast with that obtaining in the ordinary transverse framed vessel, where the deck plating especially is nearly devoid of the desirable longitudinal support. The fact of many vessels having buckled their decks between the beams proves that more efficient longitudinal support is necessary than is fitted in ordinary cases.

The new system adapts itself to a rearrangement of the pillaring of ships in such a way as to overcome a cause of serious obstruction in the holds, pillars being only required at the strong transverse beams. To obtain equivalent results in the ordinary transverse system, it would be necessary to greatly increase the strength of every transverse beam and the connecting knees.

The structure is simplified, all parts are easily accessible, and maintenance repairs are in consequence reduced, a feature that should be welcome to owners and their superintendents.

A vessel so constructed would not

Fig. 3.



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be so liable to be broached by collision. It will be obvious that before the sides could be pierced it would be necessary for the longitudinals to be fractured, whereas in the ordinary transverse framed vessel there are only the side stringers to give fore and aft support to the plating between the transverse frames, and there is a growing tendency to dispense with this support, and to compensate for its omission by increasing the thickness of the plating and by fitting transverse frames of increased rigidity.

The question of facility for carrying out damage repairs is an interesting one in considering a new system of ship construction. In the system under consideration such damage as would be caused by grounding or collision could be repaired more expeditiously than in ordinary vessels. In the event of damage to the bottom longitudinals, it would only be necessary to remove the plates in way of damage, and the longitudinals are at once accessible without removing the plating across the bottom, as is necessary in a transverse framed vessel. Damage repairs through collision could also be effected with dispatch on account of the simplification and accessibility of all parts of the structure.

It might be suggested that the deep transverses are a source of obstruction, but the obstruction is not so great as would appear to be the case from a casual glance at the sketch of midship section. In ordinary cargo vessels, the transverses could be fitted from 12 ft. to 20 ft. apart, and there are no broad horizontal plate stringers with bracket supports as in a web-framed ship, nor would it be necessary to fit widely spaced strong hold beams with broad plate stringers on the ends, such as are often fitted in deep single-deck ships framed in the usual manner.

It might here be explained, in regard to the spacing of the strong transverses in the new system, that the wider the spacing the heavier is the ship, owing to stronger longitudinals at the sides and deck being necessary. An economical spacing is found to be from 12 ft. to 16 ft., and there is practically no limit to the depth to which single-deck vessels, without hold beams, could be constructed. At the same time an important saving in weight of material, as compared with a transverse framed ship, would be effected.

It will be observed that limbers can be reduced to a minimum in the new type of vessel, that part being almost recovered for either water ballast or cargo, and between the transverses the space is quite clear of beam knees and tank-side knees.

Dr. Bruhn discussed methods of comparing transverse strength in an

Plate I.

Fig. 4.

SCALE ½" = 1 FOOT.

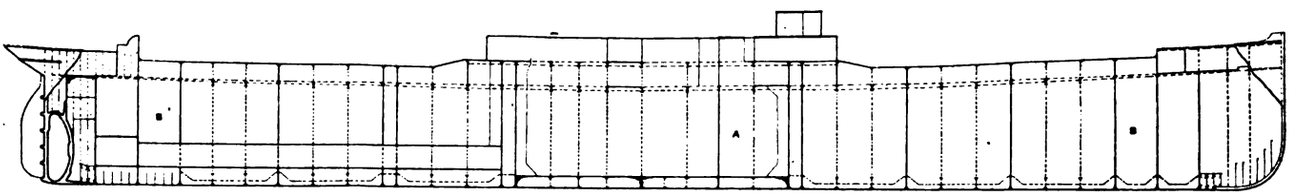


Fig. 5.

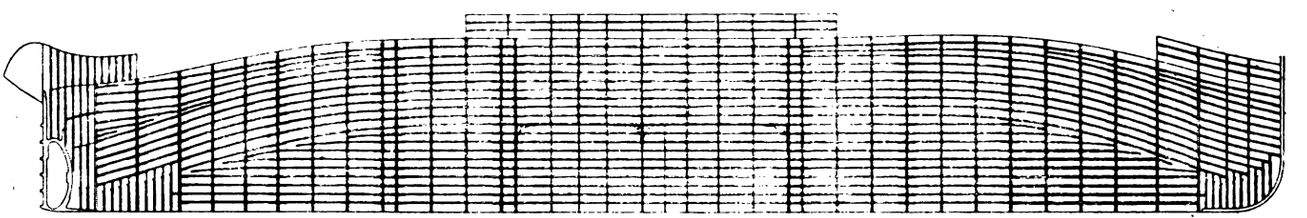


Fig. 6.

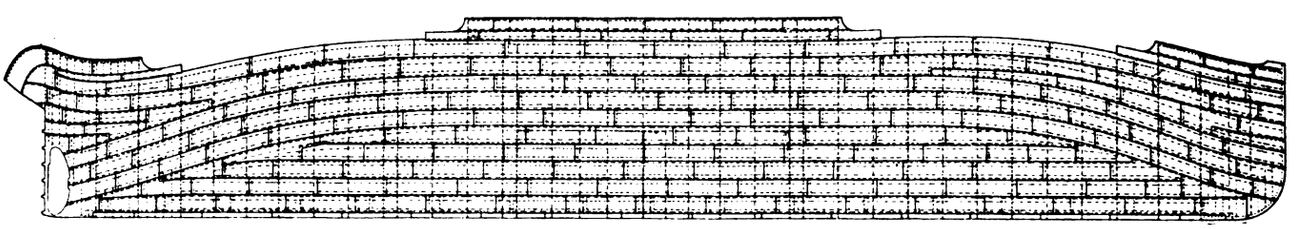
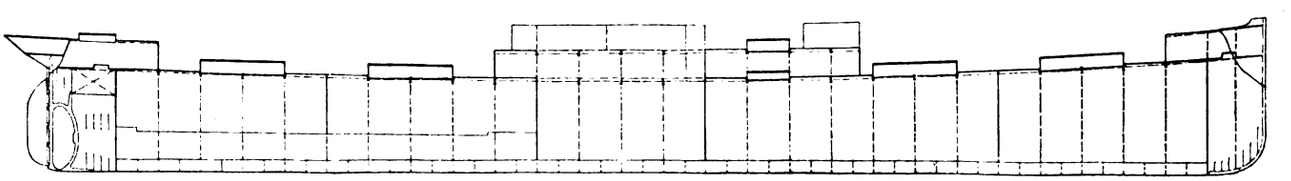


Fig. 10.



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able paper recently read before the institution, and it would unduly prolong this paper to give and discuss all calculations that have been made. For the present it will probably be sufficient to show the principal bases which have been worked to, and to state the result of these calculations, for determining the main scantlings of an oil-carrying steamer now being built by my firm, Messrs. R. Craggs & Sons, Ltd., Middlesbrough, for Messrs. Lennard's Carrying Co., Ltd., a firm who has had considerable experience in managing and repairing steamers engaged in carrying oil in bulk.

Fig. 1 (Plate I) is a midship section of an ordinary transverse-framed vessel.

For purposes of comparison, a strip of plating corresponding to a frame space is considered as part of the frame girder. The stress is then ascertained by assuming a water load on the frame girder shown by the line drawn from the gunwale to a point A, the distance D corresponding to the depth of the lower part of the frame girder below the gunwale. For convenience in calculation a mean load is assumed.

The figures obtained, without assuming any internal support from the cargo, might reasonably be taken as the stresses the frames are subject to under ordinary working conditions, the head of water assumed at the water line corresponding to the freeboard, and being a fair allowance for the increased pressure due to waves, etc.; in any case, the figures need only be used in a comparative sense, although investigations in many cases show the calculated stresses to be

Fig. 7.

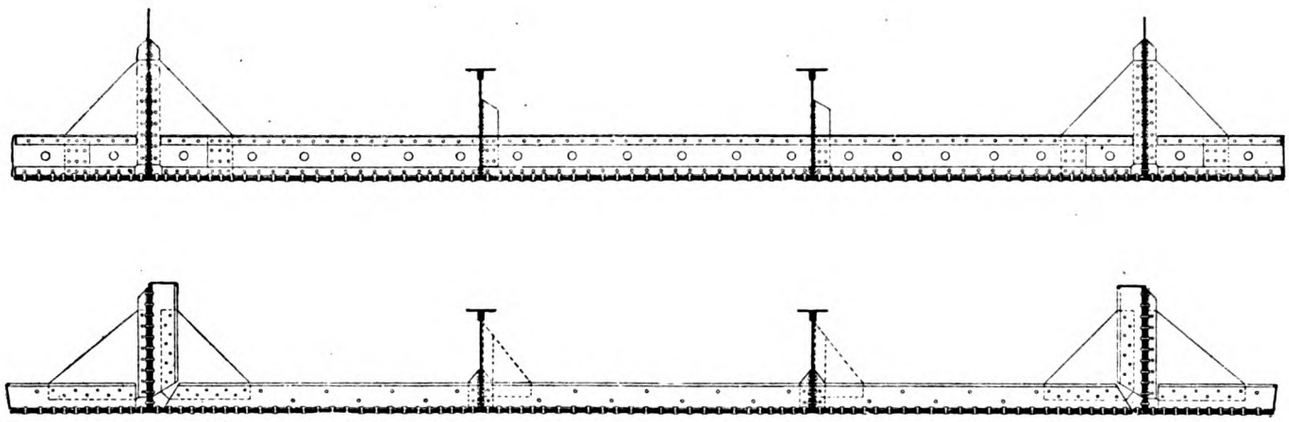
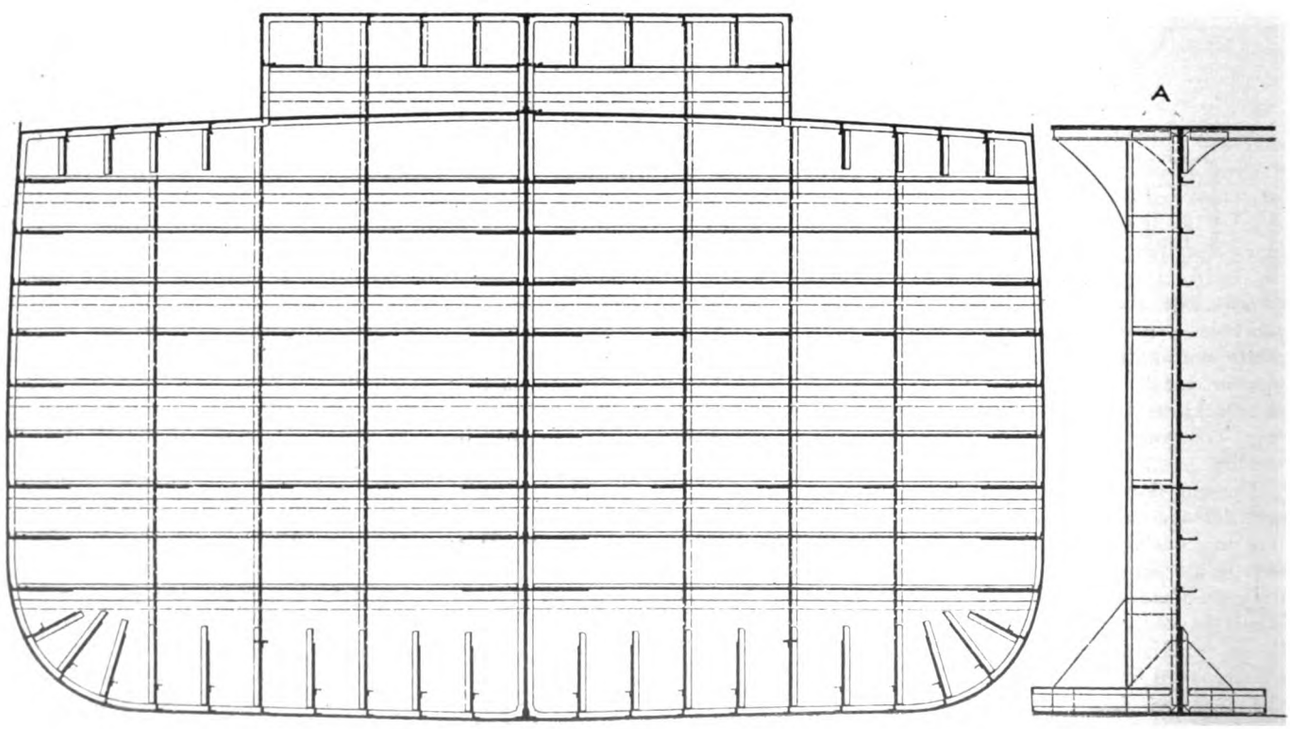


Fig. 8.



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reasonable and such as allow of a fair margin of safety.

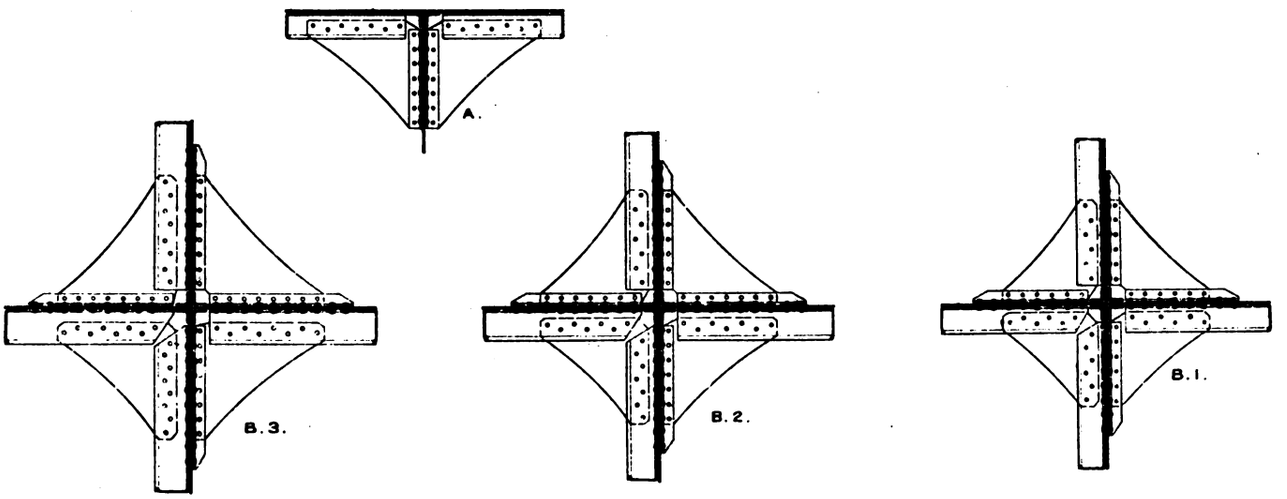
In considering a vessel with web frames, a strip of shell plating corresponding to a web-frame space is taken as part of the frame girder

In this vessel the depth of the transverses has also been increased beyond the equivalent arrived at by comparison with either a web frame or a deep transverse frame on the above basis. This has been done in

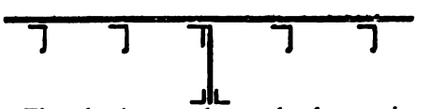
Fig. 3 (Plate I) shows the midship section; A, in the way of oil tanks; B, in the way of machinery spaces.

Fig. 4. Longitudinal section, showing position of bulkheads and arrangement of transverse materials.

Fig. 9.



along with the ordinary transverse frames on this strip of plating thus:



The load on the web frame is then taken over the web-frame space.

The results on this basis for web-frame ships generally show higher stresses than are found in the cases of vessels with either ordinary or deep frames.

For the beams comparison, one beam space of deck plating is taken as part of the beam girder and a load assumed on the deck, viz., 6 ft. high at 50 cubic ft. per ton for upper decks, and the actual height of 'tween decks at 50 cubic ft. per ton for lower decks.

Fig. 2 is a midship section showing the new system of framing. The strong transverse frames are considered as loaded in a similar manner to the ordinary transverse frames, a strip of plating being taken as part of the transverse frame girder. Although plating corresponding to the spacing of the transverses might reasonably be taken as part of the girder in the new system, as allowed in the transverse system, only half this amount of plating has been so considered in the calculations for these structures in the oil vessel referred to.

order to reduce the shearing stresses on the rivets attaching the transverses to the shell plating, and the obstruction is no detriment when liquid cargo is carried. The longitudinals are similarly considered, the length of girder being taken as the distance between the transverses, and the head of water corresponding to the distance each longitudinal D D is below the gunwale.

In addition to calculating the comparative stresses for ordinary working conditions in the oil vessel, as before mentioned, calculations were also made to ascertain the stresses under Lloyds Register test for oil-carrying vessels, viz., with head of water 12 ft. above the deck. This is a severe test, and it is open to question whether it is not too great, possibly doing injury by subjecting the rivets to stresses which are much too high, having in view the duty to be taken in service.

The calculations for the deck beams, both transverse and longitudinal, are made in the same way, a strip of plating in each case being considered as part of the girder.

Messrs. Craggs & Sons and Messrs. Lennard's Carrying Co. have kindly agreed to my publishing the principal scantlings and arrangements of this steamer, and the results of the principal calculations.

Fig. 5. Expansion plan, showing arrangement of framing.

Fig. 6. Expansion plan, showing plate edges.

Fig. 7 (Plate II). Details showing bracket conections of longitudinal bulb angle frames and bottom girders to transverse bulkheads, and also attachments of longitudinals to transverses.

Fig. 8. Arrangement of transverse bulkhead stiffening.

Fig. 9. B_1, B_2, and B_3, details showing bracket connections at the transverse and longitudinal bulkheads and (A) of the deck longitudinals to the transverse bulkheads.

In addition to the vessel being constructed on the new system, the general design, for which E. Hall Craggs is responsible, differs in some respects from the ordinary oil-carrying vessel. The steamer is of the single-deck type, having a continuous expansion trunkway above the oil tanks; quadruple-expansion engines are to be fitted amidships, and arrangements have been made for three main boilers to be fittted abreast.

The coaling arrangements are very simple and very little trimming is necessary, the cross bunker forward of the boiler room (A, in Fig. 4, Plate I) being the main permanent bunker. The bridge space is to be utilized for reserve bunkers. A

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double bottom available for carrying oil fuel or water ballast is to be fitted in the machinery spaces.

In order to avoid any break in the longitudinal strength, the trunk is continued through the bridge, and it is interesting to note that the arrangements are such as to provide for practically the same longitudinal strength through the machinery spaces as in way of the oil tanks at each end of the bridge, the omission of the center bulkhead being compensated for by the longitudinally stiffened bridge and double bottom. The tank abaft the engine room is for carrying part cargo of refined spirit, and is fitted with a cofferdam at each end. The short tanks at the ends of the vessel (B, B, in Fig. 4) provide for taking a cargo of spirit when more capacity is required than for carrying heavy oils, or these tanks may, when required, be used as supplementary tanks for special uses.

The dimensions of the vessel are as follows: Length B, P., 355 ft.; breadth, extreme, 49 ft. 4 in.; depth at center, 29 ft. The scantlings have been approved by three classification societies, viz., Lloyds Register of Shipping, Bureau Veritas, and British Corporation, and the vessel is being constructed for the highest classification of each.

Transverses.—The main oil tanks are 30 ft. long, and two transverses are fitted in each of these tanks. The transverses are 35 in. deep at the side, 20 in across the deck, 39 in. at the bottom, and 33 in. at the middle line bulkhead. They are formed of plates 9/20 in. in thickness and are connected to the shell plating by double angles. Double-face angles are fitted 5 in. × 4 in. × 10/20 in. In the engine and boiler spaces, practically the same spacing of transverses is maintained. In way of the double bottom the alternate transverses are fitted continuously around the bottom to the middle line, and the longitudinal girders are fitted in long lengths between these transverses, to which they are efficiently attached. The remaining transverses are stopped at the deep girder in the double bottom next the margin plate, and are then fitted intercostally between the longitudinals to the center line. The margin plate is fitted intercostally between the transverses and connected to them by double-riveted water-tight collars.

Longitudinals.—The uppermost bulb angle below the upper deck (No. 1, in Fig. 3) is 8 in. × 3½ in. × 8 20 in. amidships, and is reduced to 7 in. × 3½ in. × 8/20 in. at the ends; the lowest bulb angle (No. 9) is 9½ in. × 3½ × 12/20 in., and the intermediate bulb angles are graduated in size according to the depth of immersion. They are spaced 29 in. apart. The bottom longitudinals are 15 in. × $\frac{8-7}{20}$ in., graduating in depth to 12 in. × $\frac{8-7}{20}$ in. at upper turn of bilge; the angles at top and bottom of these girders are 3½ in. × 3½ in. × 8/20 in. The deck longitudinals are 7 in. × 3 in. by 8/20 in. amidships, except in way of the bridge, where they are 5½ in. × 3 in. × 8/20 in., and they are also this size at the ends of the vessel. They are spaced about 27 in. apart. As previously mentioned, the longitudinal materials at the upper and lower parts of the structure for about the midship half length are increased in strength beyond that required to resist the water pressure, on account of these parts being also subject to bending strains. The trunk deck longitudinals at sides of hatchways are 7 in. × 3 in. × 7/20 in. bulb angles; those in between the hatchways are reduced to 5½ in.

The upper deck and trunk sides are 10/20 in. thick, the upper deck stringer plate is $\frac{12-9}{20}$ in. clear of bridge and 10/20 in. in the bridge. The stringer plate at the bridge ends is 16/20 in. thick. The trunk stringer plate and trunk deck center plate are 10/20 in. thickness. The sheer strake is 12/20 in. in way of the bridge, 16/20 in. at the bridge ends, and 9/20 in. at the ends of the vessel; the side plating is 11/20 in. to 9/20 in., and 12/20 in. to 9/20 in. alternately, and the bottom plating is 13/20 in. amidships, 9/20 in. in fore peak, and 10/20 in. aft. The bridge side strakes of plating are 9/20 in. and 8/20 in., respectively. Three strakes of plating at each side of the keel plate have their midship thicknesses maintained to the collision bulkhead and the flat of bottom from No. 4 bulkhead (numbering from forward) to the collision bulkhead is additionally strengthened by the fitting of double 6 in. × 6 in. angles to the transverses and double angles 3½ in. × 3½ in. to the longitudinals.

From the expansion plans it will be observed that the plate edges up to the strake below the sheer strake are parallel to the keel, and that the spacing of the longitudinals at the ends of the vessel does not exceed the midship spacing, but is in some parts closer than amidships. The longitudinals are also so arranged that the crossing of the plate edges is almost avoided. The uppermost longitudinal on middle line bulkhead in trunk is 7 in. × 3 in. × 7/20 in. bulb angle, and the bottom longitudinal is 9½ in. × 3½ in. × 11/20 in., the intermediate stiffeners being graduated in size.

The transverse bulkheads (Fig. 8, Plate II) are supported on one side by three deep web plates A on each side of the middle line bulkhead and on the opposite side with horizontal stiffeners in line with the longitudinals on side plating and the longitudinals on middle line bulkhead. The sizes of these horizontal stiffeners are graduated according to their depth of immersion in a similar manner to those at the sides of the vessel, and on the middle line bulkhead.

The longitudinal frames and beams and longitudinal stiffeners on middle line bulkhead are cut at the transverse bulkheads, and are fitted with brackets efficiently connected to stiffeners and bulkheads in order to preserve the continuity of strength.

Reference might here be made to the attachments fitted to connect the side stringer plates and bottom side keelsons in oil vessels built on the ordinary transverse system. Preparatory to determining the scantlings for the vessel described, investigations were made with a view of ascertaining the stresses these connections are subject to under test conditions. This was found to be complex problem on account of the arrangement of materials adopted. The web frames with their attachments to the shell plating, as usually fitted, are not in themselves of sufficient strength to withstand the whole collective pressure, the intermediate transverse frames are not of sufficient strength to admit of the side stringers being omitted, and it would therefore appear as though the side stringers, acting as girders between the transverse bulkheads, did the bulk of the work in supporting the transverse frames without obtaining the requisite support from the web frames.

If the side stringers in an oil steamer with ordinary framing and web frames are considered as girders between the transverse bulkheads, the stresses at the ends of the girders are found to be abnormally high, and such would appear to be the ex-

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planation for the serious troubles experienced in so many of these steamers at the bracket attachments to the transverse bulkheads. The investigation points to the necessity of further increasing the depth of the web frames in ordinary oil-carrying vessels, and also of fitting double-riveted attachments to the shell plating as prescribed by the rules of Bureau Veritas.

It is of interest to note, in the new rules of the British Corporation Registry for oil carrying vessels, that this society has the courage to provide for "deep frame" construction in this type of vessel. Close investigation shows this to be distinctly preferable to the web framed arrangements generally adopted, and this is confirmed by the experience gained in steamers having deep frames in deep water ballast tanks.

In the system of framing under consideration, it is a simple matter to single out and determine the stresses on all parts of the structure under test conditions. Under these conditions the rivets attaching the brackets to the transverse bulkheads are subject to stresses in no case exceeding 3½ tons per square inch, which is only a fraction of that to which the stringer attachments in ordinary vessels are subject when considered under the same conditions. The strength of the rivet attachments in all parts of the structure in the new system have also been carefully investigated. The transverses are connected to the shell plating with double angles, having the rivets spaced about four and half diameters apart. The rivets attaching the longitudinals to the shell plating are spaced six diameters apart, except in the vicinity of the transverses. The shearing stresses at these parts being at a maximum, a closer spacing has been adopted, viz., from three and a half diameters to four and a half diameters, except at the uppermost longitudinals, where a uniform spacing of six diameters has been adopted.

It is a debatable point whether direct attachments of the longitudinals to the transverses are necessary, or whether the shell plating itself does not provide a gusset binding the two parts of the structure efficiently together. It would appear that if both longitudinals and transverses are efficiently riveted to the plating in the manner previously described no individual movement could take place.

In this oil-carrying steamer, however, and having in view the testing of tanks before the vessel is launched, it was decided to attach the bottom longitudinals to the transverses with vertical lugs having six rivets in each flange, the lower bulb angles with four rivets and the upper ones with two rivets. These attachments, whether structurally necessary or otherwise, were expected to facilitate the erection of the steamer, but in actual practice they proved of little importance. The transverses, where connected to the middle line bulkhead, are attached to the plating with single angles double riveted, and, as at the skin plating, the rivets are closer spaced in the horizontals in the vicinity of the transverses. The deep web plates on transverse bulkheads are attached with single angles having the rivets four and a half diameters apart and a uniform spacing of five diameters is adopted for the lower horizontals and six diameters for the upper ones.

The comparative longitudinal stresses calculated under the usually accepted loaded conditions, viz., by assuming the vesel on a wave of her own length and the bending moment as $\frac{D \times L}{35}$, show the tension at the bridge gunwale amidships to be 18½ per cent less in the vessel built on the new system, the results being as follows:

New system.....6.7 tons per sq. in.
Ordinary system....8.22 tons per sq. in.

In making the comparison at the bridge ends, the bending moment was assumed $\frac{D \times L}{45}$ on account of these parts being some distance from amidships. (Whether the factor 45 is correct or otherwise is unimportant since it would not materially alter the comparison.) Under these conditions the comparative stress at top of trunk is 10.8 per cent less in the new system, the results being as follows:

New system.....6.61 tons per sq. in.
Ordinary system....7.41 tons per sq. in.

The comparative transverse and deck stresses on the bases previously described are shown in the table. Although this comparison of stresses shows the structure to be of generally increased strength, yet there is a saving in weight of material estimated at 275 tons. The saving is due to the redistribution of material, which admits of dispensing with a large number of transverse connections. The vessel, in consequence, could carry 275 tons more deadweight on the same draught, with the same model and with the same consumption of fuel, thus considerably increasing the earning power of the steamer.

A few remarks as to the erection of the ship may be of interest. The keel plate was laid and middle line keelson fitted as usual. The after peak is framed with the usual transverse frames, and the erection up to the peak bulkhead was the same as in ordinary vessels. The peak bulkhead and the two transverse bulkheads forming the two short compartments aft were then put together on the ground, erected and secured in position, middle line bulkhead fitted, and longitudinals placed in position.

The two transverses in the next compartment were erected on the port side of the ship, circular tunnel

OIL TANK SHIP.
Transverse System.

	Tons per sq. in.
Deep frames (increased as in deep tanks)	7.13
Web frames (increased as is usual in oil steamers)	8.21
Deck beams (in bridge)	5.04
Deck beams (clear of bridge, and increased as usual in oil steamers)	4.32
Maximum shearing stresses on rivets attaching deep frames to shell plating	6.7

OIL TANK SHIP.
"Isherwood" System.

			Tons per sq. in.
Transverses—			
Side			3.76
Bottom			3.67
Deck			0.96
Deck Longitudinals—			
In bridge			3.8
Clear of bridge			2.25
Skin Longitudinals.	Nos. 1	Bulb Angles.	1.17
	" 2		2.34
	" 3		3 5
	" 4		4.49
	" 5		4.38
	" 6		4.65
	" 7		4.92
	" 8		5.46
	" 9		5.89
	" 10	Plates and Angles.	4.02
	" 11		4.34
	" 12		3.97
	" 13		3.62
	" 14		3.31
	" 15		....
	" 16 to 19		3.31
Maximum shearing stresses on rivets attaching strong transverses to shell plating			4.94
Maximum shearing stresses on rivets attaching longitudinals to shell plating			1 to 5

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built in, middle line bulkhead fitted, and transverses on starboard side then erected. The longitudinals at bottom and sides were lifted into position, and the next transverse bulkhead erected, and so closed up that tank. The same method of procedure was repeated for the remainder of the vessel. The erection of the forward part, where clear of tunnel, showed the simplicity of the system.

The brackets for the attachment of skin longitudinals to the transverse bulkheads were hydraulically riveted to the longitudinals, and the lugs on bulkheads to receive these brackets, horizontal stiffeners on transverse bulkheads and on middle line bulkhead were also hydraulically riveted to the various parts before they were taken down to the berth.

It will thus be seen that as the erection advanced forward the work was, tank by tank, left in a position ready for riveting up, all the materials required for the structure being in position, with the exception of the longitudinal beams, and as these did not delay progress they were followed up at a convenient interval.

With regard to ribanding, one stout rough riband each side was used at the top of the transverses for securing the same and one on the transverse beams, each side, for fairing purposes, and these were all that were found to be necessary. The longitudinals take the place of ribands and only require to be secured to the transverses and to the lugs on the transverse bulkheads, which were carefully templated, and no other fairing was required. No difficulty was found in the laying off of the vessel, and practically the whole of the framing of the structure was made to templates prepared in the drafting loft.

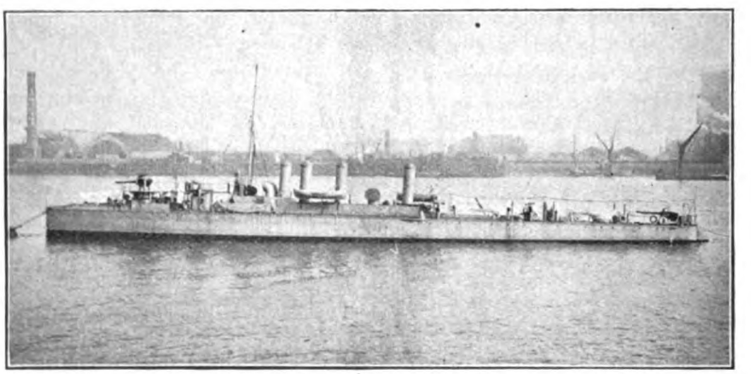
We did not have the assistance of the usual experienced frame erectors, and nearly all the erecting has been done by apprentices, the northeast coast carpenters, unfortunately, being out on strike owing to a wages dispute.

The officials, workmen, and all concerned took a most lively interest in the work, and the predicted obstacles and difficulties of erection of a ship on the new system were found to be non-existent.

Fig. 10 (Plate I) shows an arrangement of transverse materials in a single-decked cargo steamer, having poop, bridge and topgallant forecastle. The spacing of transverses shown is 12 ft., except in way of the double bottom, where an intermediate transverse is shown. This transverse enables the longitudinal stiffening in the bottom to be of bulb angle section, thus making this part very easy of access.

TORPEDO BOAT DESTROYERS FOR THE GREEK NAVY.

The last of the four torpedo boat destroyers built for the Greek navy by Messrs. Yarrow & Co., Ltd., of Poplar and Glasgow, has now been completed and will be handed over very shortly. These vessels, named Thyella, Nafkratonssa, Lonki and Sfendoni, are of the following dimensions: Length, 220 ft.; breadth, 20½ ft.; depth amidships, 12 ft. 4 in.; displacement, 350 tons; indicated horsepower, 6,000, and contract speed 31 knots. We are able to reproduce one of these vessels from a photograph supplied by the builders.



TORPEDO BOAT DESTROYER THYELLA, BUILT BY YARROW & CO., LTD., POPLAR.

The main machinery consists of two sets of four-cylinder, triple-expansion engines, driving two shafts, steam being supplied by four Yarrow straight valve boilers. The hull is built throughout of high tensile steel. The armament consists of two 76-millimetre and four 57 millemetre Hotchkiss quick-firing guns and two torpedo tubes. It is worthy of note that when these vessels were proposed, no vessel of a similar type and displacement was armed with such heavy artillery.

The bridge and platform extend from the conning tower to well abaft the foremost boiler room bulkhead, the uptake from the forward boiler being carried horizontally for some distance to enable this to be done. It is most important, as all navigators know, for the steering position to be as far removed from the bow as possible, and by means of the device adopted by Messrs. Yarrow & Co., of conducting the gases from the forward boiler for a certain distance in a horizontal direction before joining the funnel this can be carried out.

The speed obtained on the full power trials of the Lonki, with a load of 60 tons was 32.427 knots on the measured mile, and during a continuous run of three hours' duration, 32.535 knots. The steam pressure in the boilers was 250 pounds per square inch; the air pressure in the stokehold 1½ in., and revolutions 415. During a previous trial at a cruising speed of 14 knots, 35.09 knots were run to the ton of coal burnt, giving a radius of action at this speed of 2,231 knots. Considering the speed obtained with these Greek destroyers and that each vessel costs about one-third of the recently constructed 33-knot destroyers for the British government, many naval authorities are of the opinion that the small additional speed obtained in the latter type is not worth the enormous additional cost.

NEW CITY OF CLEVELAND.

The Detroit & Cleveland Navigation Co. has issued a panoramic photograph of the Detroit water front embracing a picture of the new steamer City of Cleveland leaving on her trial trip. The photograph well displays the magnificent appearance that this steamer makes in the river against the background of the sky scrapers of Detroit. The new steamer will go into commission between Detroit and Cleveland some time in June. The features wherein this steamer differs from other lake steamers are the passenger elevator, double water bottom, sprinkling system, bow rudder, wireless telegraph, convention cabin, a Venetian garden buffet, private telephones in all staterooms, running water in all state rooms, private parlor with bath and some with verandas, and the system of washed and air-cooled ventilation.

The Dubuque Boat & Boiler Works, Dubuque, Ia., are progressing well upon the two dredges for the United States government.

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The Turbine Question

BY HENRY PENTON.

For many reasons the particulars of steam performance of the Lusitania are to be welcomed. For some years, in fact, ever since the turbine became a factor in steam engineering, information as to actual performance has been eagerly sought, but with small success. Those who possessed it and who were in the nature of things few in number, either felt that the data obtained were not satisfactory or else to be jealously guarded. The numerous installations for electric service have supplied very little of value to the marine engineer whose requirements are of an entirely different order. Moreover, it has become the custom in turbine practice to state the steam economy in terms of the shaft horsepower, either for all purposes or for turbine only, neither of which methods enables a comparison to be drawn between the turbine and the reciprocating marine engine, which usually operates most, if not all of the auxiliaries which form a necessary and integral part of the propelling system. Coal performance, while interesting to the owner, is really of secondary importance to the engineer, who seeks to know the actual heat efficiency of the two systems. Coal is a factor of such widely varying quality and the evaporative efficiencies of different boiler installations also vary so widely, that figures as to coal consumption alone are entirely misleading. The actual weight of steam used is the only true basis of comparison and the difficulties in the way of obtaining this accurately aboard ship are manifold. The methods easily available ashore in the way of tanks and scales for measuring and weighing feed water are out of the question aboardship and mechanical methods must be resorted to. On the Lusitania, for instance, the water rate was obtained by counting the strokes of the feed pumps and applying thereto a correction for the unavoidable losses, obtained by preliminary tests checked by other tests after the trials. This is of course approximate, but probably sufficiently accurate for all practical purposes. The meter is frequently employed but is no more accurate than the pump method. However, the figures supplied are the best obtainable and are distinctly more complete than any yet set forth and exhibit the best performance so far claimed for any marine installation, and our British cousins are entitled not only to our thanks, but to all and more credit than they ask.

The figures do not demonstrate that the turbine, viewed merely as an engine, has done anything noteworthy. There are scores of well authenticated performances of triple and quadruple reciprocating marine engines which surpass it, even in this enormous installation, where everything favors best performance. The steam consumption for turbines alone is given as 13.1 pounds, and for auxiliaries (other than distilling and heating) as 1.75 pounds. It is, of course, incorrect to assume that all the auxiliaries are chargeable to the propelling machinery, but it is perfectly safe to assume that at least 1.25 pounds or 72 per cent of the total consumption of auxiliaries which cover air pumps, circulating pumps, feed pumps, fan engines, oil pumps, etc., besides electric lighting, steering, etc., should be so charged. This would give a steam consumption of 14.35 pounds per horsepower per hour for the propelling machinery complete, a performance which falls considerably short of that of reciprocating engines in first class installations. The steam making end of the plant is remarkably efficient, as is shown by the high rate of evaporation, which is probably chiefly due to the coal employed, average Welsh coal for example having a heat value about 15 per cent higher than good grades of American steam coal.

Judged merely by coal performance, which as before stated is not a true comparison, the Lusitania's 1.5 pounds for all purposes falls a long way short of the trial of the St. Paul, which gave an average for 24 hours of 1.22 pounds.

The St. Paul is not selected as an American ship, but merely because of the fact that her trial figures are among the few available of fast trans-Atlantic passenger ships.

In the merchant service other than passenger ships, while there are abundant records of trials, there are very few instances where an accurate and complete steam account has been kept, because of the difficulty of determining the proportion chargeable to auxiliaries.

Comparisons of gross steam consumption of such a ship as the Lusitania, with numerous large and small independent auxiliaries, and a freighter with few, and those chiefly driven by the main engines, would be of no value, but fortunately we have a record of a trial of the Rappahannock, a coarse freighter, with triple engines, carried out by Prof. Weil some years since, in which the steam from auxiliaries was taken to an independent condenser and collected and weighed and the net steam chargeable to engines found to be 13.07 pounds per horsepower which includes the air pump, driven from main engine. This is moreover a comparatively small installation, the power on trial, ordinary service conditions, being 1,148. The feed water was measured by a meter tested and calibrated for both rate and temperature before and after the trial and while it may not be absolutely accurate is probably just as nearly so as the method used on the Lusitania and the probable error would not appreciably affect the result.

The rate of evaporation was low, only 9.04 pounds per pound coal from and at 212 degrees, as compared with the Lusitania's 11.1 pounds, therefore for equal rates of evaporation the Rappahannock's coal rate would be 1.2 pounds for engines only as compared with the Lusitania's 1.3 pounds for turbines only.

There is nothing specially remarkable about the Rappahannock or her equipment, the latter is duplicated in numerous other ships, and there is no reason to suppose her performance is either better or worse than theirs. If we take the St. Paul again and give her credit for the same rate of evaporation, the steam rate for all purposes, charged to main engines, would be only 13.5 pounds per horsepower, and if corrected for auxiliaries would probably fall to about 12 pounds. This is, of course, guess work, because we do not know what the amount of feed water or rate of evaporation were, but if the latter was not so high as the Lusitania's then so much the worse for the turbine. Here, then, we have both large and small units, passenger ship and freighter, and the reciprocating engine still has materially the best of it.

This is not in any sense a criticism of the Lusitania as a ship, she and her sister are beyond that, it is merely a comparison of two types of

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marine motors from the viewpoint of steam efficiency.

It is freely conceded on behalf of the turbine, that, for ships of war, where low head room is valuable for protection of machinery, and for such ships as the Lusitania, where the enormous power required can only be had within the limits of practicability by higher rotative speed than would be possible with reciprocating engines, it has decided advantages, but these cases have no real bearing on the general subject. It saves nothing in weight, nothing in floor space, nothing in fuel, and in first cost is very much more expensive than any type of reciprocating engine. An examination of the construction of the turbine (at least of certain types) gives one the shivers to think of what a breakdown means. If a design of cylinder and valve gear could be worked out which would enable the reciprocating engine to get rid of its exhaust steam at velocities which would make it possible to more nearly realize the value of higher vacuum, the turbine would have no economic standing. This fact, together with the non-reversible construction of the turbine, have led to the adoption of combination units where the first stages of expansion take place in reciprocating engines and the final stages in low pressure turbines. This arrangement is being worked out on a large scale in the new White Star ship, and was advocated by Prof. Rateau, of France, when in the United States in 1903, but has since been actively favored by British builders, including Parsons.

The problem is almost entirely one of final pressures. The exhaust-valveless turbine allows of carrying expansion down to nearly condenser pressure while the reciprocating engine, hampered by valve action and tortuous passages, is not able to get nearer than 4.5 to 5 pounds and it is not possible to affect this to any appreciable extent by a considerable range in vacuum.

Turbine advocates are still numerous who reiterate the claim, so widely made when the turbine first appeared, that with its adoption, vibration would disappear, in spite of the fact that each installation either proves nothing or else proves the contrary. We say proves nothing because there are abundant instances of ships with reciprocating engines which are as quiet or quieter than any turbine ship so far built. We quote here an editorial from the *London Enquirer* on the subject which must be accepted as authoritative:

THE VIBRATION OF SHIPS.

In the vibration of steamships the fact that the frequent regular repetition of relatively minute forces may generate enormous effects is made manifest. The unbalanced weights in a reciprocating engine are but a tiny fraction of the whole displacement of a ship, and yet they can, by their persistence, throw the great structure into a state of tremor, and may with but little augmentation, actually endanger its integrity. The parallel with the historical example of a suspension bridge being set oscillating and ultimately destroyed by the well-timed impacts of a pellet from a pea-shooter is obvious. It is the succession of blows, minute and powerless as individuals, but mighty when applied in succession, and timed to synchronise with the natural period of oscillation of the structure, that sets up the disagreeable and dangerous vibration of ships. The fact is, of course, universally known, but like other recognized facts it has been, or appears to have been, if not forgotten, at least treated with less consideration than it demands.

It was presumed that when the turbine took the place of the reciprocating engine, ship vibration would cease. The very existence of the turbine depended upon its perfect balance, and vibration in it was, therefore, out of the question. Hence, the power assumed to be at the root of the evil being removed, the evil itself would disappear. The falsity of this argument was probably proclaimed to deaf ears by a score of ships, which in spite of all that science could do to balance their engines still vibrated, but ship builders, possessed with the idea that the engine was the sole, as it is no doubt the principal, cause of the trouble, concentrated their attention on it alone. The turbine has shown us their mistake. Engine vibration has indeed ceased, but there is not a single turbine ship running which does not suffer at one speed or another from vibration produced by some other cause or causes. It is not so great in amplitude as that of reciprocating ships, but it is none the less a defect which defies the naval architect and engineer. In the Mauretania it is so marked that a special correspondent of the *Times* has asserted that at 25 knots it is difficult either to read or write, save on the lower decks. The tremor is of a peculiar order, and during a trip on the same vessel we found that it followed a cycle, which may be described as beginning with a two seconds pause, succeeded by a wave of vibration, which augments gradually for some five to seven seconds, and then dies wholly away in the same time. The amplitude was, at 24 knots, very small, and the movement disappeared altogether at slower speeds, but at a higher velocity it is apparently—we speak without direct experience—even more marked. No disgrace attaches to the builders or designers for the existence of this state of affairs; the Mauretania vibrates probably less than any other vessel of her speed in the world; but, on the other hand, that a ship on which the highest scientific and engineering skill has been expended should be still subject to a defect of the kind is a reflection on our state of knowledge which every effort must be made to remove. The cause, no doublt, is to be found outside the vessel; and whilst we shall not go so far as to say that the mere friction of water over a comparatively rough surface cannot set up vibrations as a rosined glove does in musical canes, yet the propellers, as the only moving things outside the hull, must be held principally responsible. But even if we admit that the propellers are at the root of the matter, we are still far from a solution of the problem. If it lay merely in a lack of balance of the blades, the difficulty could and would be readily overcome. Propellers, even for a large ship, may be corrected in this respect to a nicety, but still the vibration remains. Possibly, if the adjustment were made with the blades submerged to their full depth in sea water a difference from the balance in air might be discovered. It is conceivable that the density of the blades, or even of parts of the boss, which at high speeds in an important detail, is not the same at all parts, and it is possible that when submerged a lack of balance results. We can see that in a four-bladed propeller, for example, a blade with a large hollow in it might be balanced by one of denser and thinner material on the opposite side, and yet such a propeller would, under water, be thrown out of balance by the different displacements of the blades. Only a close mathematical inquiry could say what effect such differences in volume and density as are likely to exist could have. Another cause of trouble may possibly be found in errors of pitch and spacing of the blades. Propellers are not invariably made with the precision of machine work; the blades are cast and attached to the boss, but care is not always taken that they are spaced absolutely equal, and that the axis of each is truly radial. Propellers are designed to produce the maximum thrust, and the vibration that they may cause has, too often, been left to chance. It is time that a set of blades was made for a big ship with as much accuracy as the engines themselves, and machined in every part. Instructive results would ensue. We are aware that machined propellers have been tried, but we believe only on a small scale and with doubtful results. The cost has generally precluded their use. We do not assert by any means that machining the blades would cure the trouble; for other causes than irregularities of construction are at work. It is held, for example, that the down-going blades as they move from water less to water more dense, and from regions of less to regions of greater pressure, meet with increasing resistance. If this is indeed a fruitful source of vibration, a

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cure in any single propeller must be looked for in vain; the conditions are beyond the power of man to change. But whilst we cannot, if that is the case, do anything for one propeller, we may effect an improvement by dealing with a group. For example, the synchronisations of two propellers are likely to cause rhythmical impulses which may be reduced by slight changes in one or the other, or even by such a large change as the employment of a four-bladed screw on one side of a ship and a three-bladed on the other; then, again, the race from a forward propeller may act upon the propeller behind it and set up vibration, and the propinquity of propellers to the hull and their direction of rotation may have effects.

All these points demand careful examination. They are known and talked about by marine engineers, but the fact that the latest and best of our ships are not free from propeller vibrations is evidence sufficient that the subject requires fuller and more exhaustive examination. And since, as we have said in our opening paragraph, the enormous results are produced by very small causes, the conquest of the difficulty can only be effected by thorough-going scientific investigation carried out with the care and precision of laboratory experiments. It might be found that the absolute reduction of vibration was an excessively costly process, but to have absolutely definite knowledge of the causes producing it would give us the means of attacking it, and in the course of time the difficulties would be overcome. It remains only to say that we have not in these few notes attempted to deal with the comparatively brutal plan of adding useless weight and strength to the structure in order to mask or kill the effects. That is evading, not overcoming the difficulty.

The writer has maintained for years that the question of vibration was almost entirely independent of the type of motor employed, though it is not denied that it may be aggravated or modified by design or adjustment. As long ago as 1896 he drew attention to pronounced vibration in a steel tow barge, and again in 1899, to a still more marked instance, also a steel tow barge. In the latter case the vibration was recurrent, that is to say, like the case of the Mauretania referred to above, beginning with a state of rest it augmented to severity and died away, reaching greatest amplitude at intervals of about 30 seconds, with a frequency of about 90 per minute. In steamships many attempts have been made to avoid vibration by special systems of balancing, including irregular crank angles and arrangements of cylinders, and many claims made therefor, but the fact remains that no example is yet forthcoming of a case of vibration being cured by changing from one design to another in a given ship, while there are many where even the most elaborate and carefully worked out systems have not accomplished their purpose. Neither does the fact of one ship fitted with engines balanced on any particular system being quieter than another fitted with engines differently arranged, prove anything whatever, because instances are numerous of ships identical in every respect, exhibiting entirely diffent characteristics in the matter of smooth running. At one time it was the general impression regarding our lake ships that when vibration manifested itself it was due to light construction, but instances of adding enormously to construction weights without effect went far to modify that view. There is the well known case of a ship which had a pronounced case of the "shakes," and which no effort seemed to improve, losing a foot of the tip of one blade of her propeller and running quiet for the first time. Probably more vibration troubles have been cured by careful overhaul of propeller than in any other way. As our ships have grown in size vibration troubles have become less common, probably because the period of the ship having lengthened it no longer coincides with the engine and propeller speed, although the prevailing type of engine has not changed. No type or design of engine can be said to have demonstrated any thing definitely in this respect, except that it has comparatively little influence. Distribution of weights in the ship, either of ballast or cargo, have notoriously more to do with the case than any other one thing. Depth of water is always a disturbing factor. The only thing the turbine accomplishes is in increasing the frequency and reducing the amplitude of vibration and this to such an extent in some instances as to be unbearable. And as the rotative speed increases a lack of balance or adjustment in the propeller is accentuated, and it appears likely that we have been for years working in entirely the wrong direction, seeking to remedy defects where they did not exist and probably, in many cases, only succeeding in accomplishing something by having introduced a counter-irritant. One thing only we have demonstrated, and that is that no man can determine definitely, in advance, what the characteristics of the actual ship will be in respect of smooth running, regardless of the type of motor adopted, and the experience of the Lusitania and Mauretania, the largest and costliest ships ever built, and on which the best talent of the world was concentrated, is merely corroborative.

BILL BOWLINE'S REPLY.

Old Bill Bowline recently made some remarks in *Shipping*, New York, concerning a drawing of the clipper ship Flying Cloud by Capt. F. D. Herriman of the Great Lakes Register published in the MARINE REVIEW of March 19. In the MARINE REVIEW of April 30 Capt. Herriman trimmed that Ancient Mariner a bit. After considerable silence, Bowline expressed his feelings to his friend Ropesender as published in *Shipping* as follows:

"I very much feared after reading the remarks of Capt. F. D. Herriman in the MARINE REVIEW, of April 30, that he had taken the wind out of old Bill Bowline's sails, and that the Ancient Mariner was left far and away to leeward. So with rather dismal forebodings I laid alongside the old chap and unfolded the paper to his tarry gaze. As becomes a man of profound wisdom and wide experience, he sat in silent rumination for a long time before discharging himself of utterance. Then he spake thus: 'I've got nuthin' agen this Cap'n Herriman. In course, he's rubbed it inter me a bit, but I guess he means well. Now, I says agen that the cap'n is offen his course considerable. Them 'ere stuns'ls I never saw set with the wind forrad o' the beam, an' the yards jammed agen the backstays—specially in them "gentle" winds when the man at the wheel might get her aback while shiftin' his quid and carry away stuns'ls, yards, along o' other gear. In course, I'm no navigator, and ain't up on "deflection" an' the like, but I fails to see why that 'ere spanker boom in the drawin' is hauled purty near amidships when the Flyin' Cloud is runnin' free. Does that come from the "deflection" o' the mizzen sails, too? Further, mate, yer can put it in the log that I thanks this 'ere Cap'n Herriman for his good wishes to an old shellback like me, but about 30 years ago I war shipmates with a Salem man who war in this 'ere very same Flyin' Cloud two voyages an' he had a paintin' and a wooden model of her which he made hisself. Both on 'em is in New York now, and they is different from this Herriman drawin', because that craft had a sharp clipper bow (not a bluff bow) an' a round stern, not the chopped-off Yankee stern in the picter o' Cap'n Herriman's. That's all I has to say to this piece o' his in the MARINE REVIEW.'"

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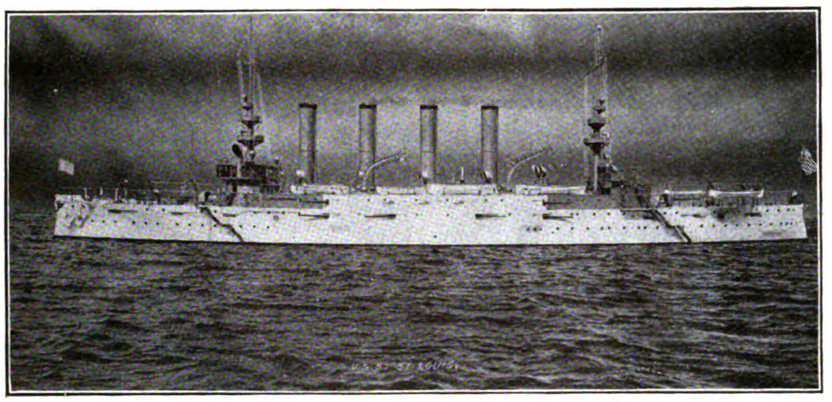
The Art of Marine Model Making

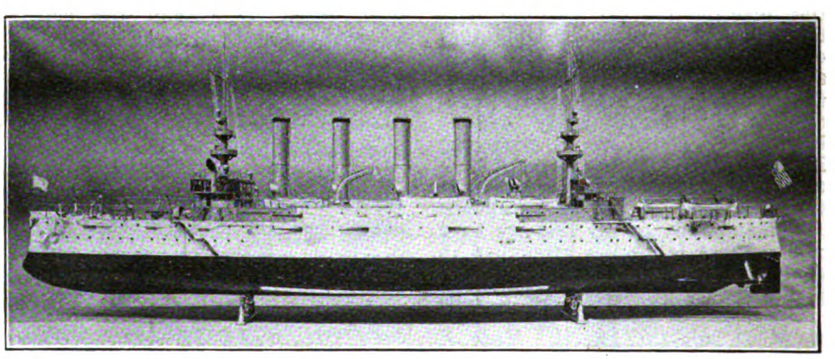
Those who had an opportunity of inspecting the recently completed model of the steam yacht Vanadis when on exhibition last month at the works of the builders, the H. E. Boucher Mfg. Co., New York City, could not fail to be impressed with the close attention to detail and delicate finish of this masterpiece in the art of marine model making. The Vanadis, now nearing completion in a British yard, is being built for C. K. G. Billings, to whose order the model has been finished, and is 260 ft. long over all, 230 ft. on the water line. The model, which is built to ¼-in. scale, is about 6 ft. long over all, and stands as she would appear in dry dock, keel and bilge blocks complete. Where possible the actual material used in the construction of the yacht is in the model. The chart room, bridge, boats, and parts of the upper works are of mahogany, an extremely difficult wood to work on usually, and especially so in model construction. The boats, six in number, are of various types and sizes, each an exact reproduction of the original. The power boats are equipped with tiny motors, built from the blue print, and the fittings are complete to the smallest detail. The davits to which the boats swing are working models, blocks and falls complete.



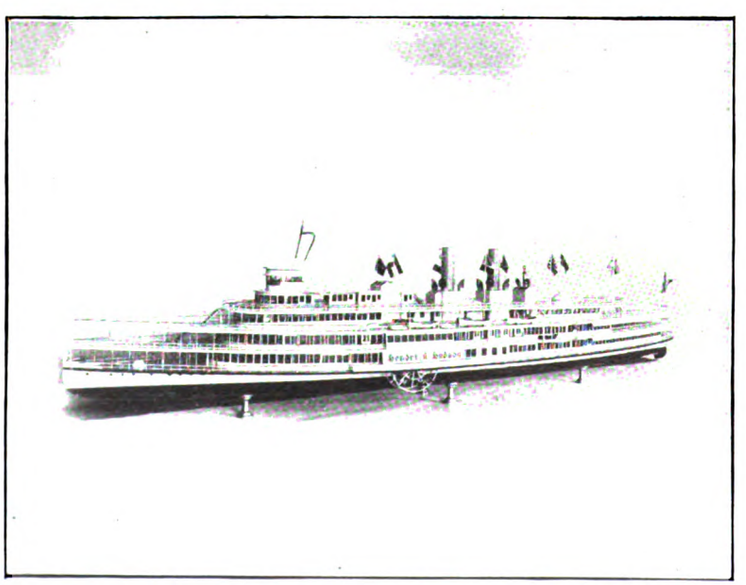
UNIQUE PHOTOGRAPH OF MODEL OF U. S. S. ST. LOUIS.

Some idea of the delicacy of the fittings can be gathered from the knowledge that the turn buckles in the stays are not much thicker than the ordinary good-sized pin, and about one-third the length. The gratings are built, each strip having been carefully fitted, as is all the carpenter and joiner work, where possible, throughout the model.

The accompanying illustrations give a fair idea of the varied types of craft built at the model ship yard. The two views of the United States ship St. Louis show the finished model mounted on a stand and, to all appearance, steaming easily through an open stretch of water. As it is not our intention to deceive, however, we hasten to explain that what appears to be the model "under way" is merely the original photograph cut out and carefully attached to another photograph of the open sea. Mr. Boucher, who experiments at some length in endeavoring to produce the right effects, shows in this engraving the possibilities of the camera in model photography. Needless to remark the warship models are also exact reproductions of the original.



MODEL OF U. S. S. ST. LOUIS.



MODEL OF HUDSON RIVER STEAMER HENDRICK HUDSON.

The models of the transport Sherman shown were exhibited by the government at the Jamestown exposition, as were cross-sectional models already described in the MARINE REVIEW. These models are about 12 ft. in length, and it is estimated that there are in the sectional model about 10,000 separate parts. A working model of a large dry dock was also exhibited and proved intensely inter-

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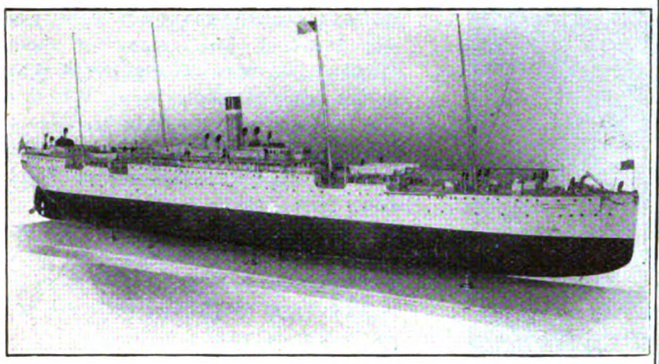
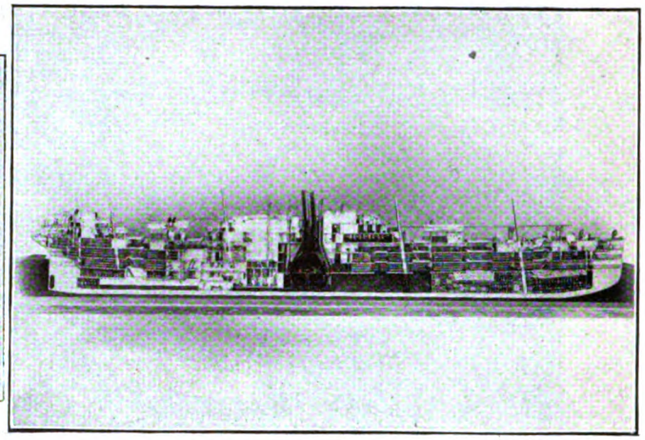
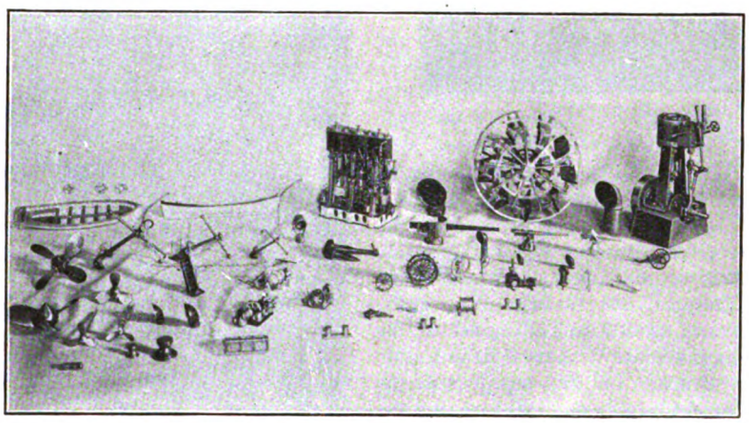


MODEL SHOWING EXTERIOR OF TRANSPORT SHERMAN.



MODEL SHOWING LONGITUDINAL SECTION OF TRANSPORT. THERE ARE SAID TO BE 10,000 DETAILS IN THIS REMARKABLE PIECE OF WORK.



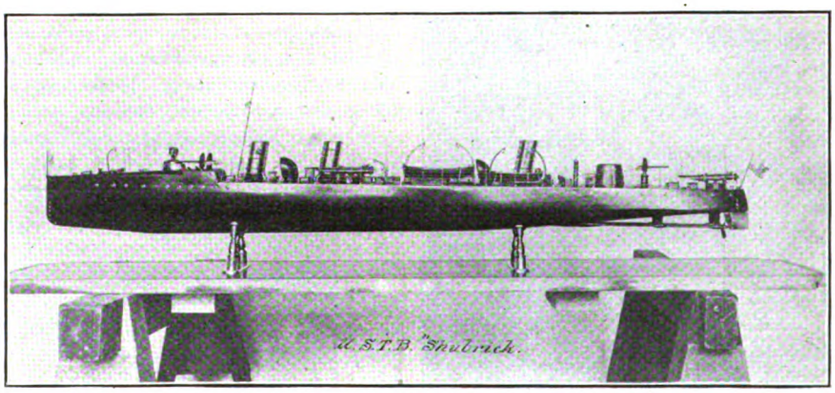
MODEL FITTINGS FOR MODEL SHIP.

esting to those not versed in the manner of docking a warship or other large steamer for hull cleaning or repairs.

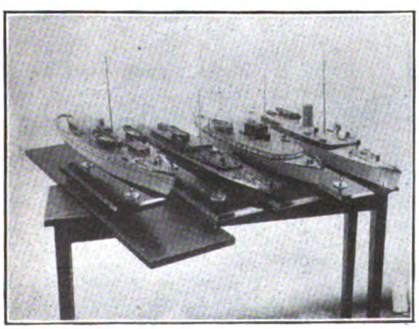
The model ship fittings in the group are, like the vessel models, built to scale, and are as near perfect as the resourcefulness and skill of the machinist can make them. The model of the triple-expansion engine is complete in every detail, and, though not intended to be operated by steam, is still workable. Some idea can be gathered of its size when it is known that the model can rest snugly on the outstretched hand, with room to spare. The single-cylinder reversing engine to the right of the illustration is, however, a steam-driven working model. An engine similar to this single-crank model, but smaller, is installed in a model yacht built by Mr. Boucher in his younger days. This steam yacht has a complete installation of propelling machinery, but lacks the fine lines and finish of Mr. Boucher's work as a professional model maker, therefore, seldom sees the light of day. In its honor be it said that it has earned the reputation of being a flyer, and, though occupying an obscure corner on the shelves of the model ship yard, its past performances are by no means forgotten.

The guns shown can be swung and adjusted, though the largest is only a matter of about 4 in. in length. Needless to say, they are not working models in the proper sense of the word. The cargo winches with the business-like air do not operate, though the drums, wheels and other parts in their make-up have been carefully machined and fitted. The different types of propellers will be noted, especially the built model of a four-blader. The paddle wheel is built of brass and is a splendid example of the model maker's art.

It is hardly necessary to remark that the artisans engaged in the construction of these models are the finest procurable in the separate branches of the business. The land swarms with machinists, carpenters, painters, riggers and the many other representatives of the ship building industry, but there are mechanics and mechanics. A visit to the H. E. Boucher Co.'s shops will show, for instance, that



MODEL OF UNITED STATES TORPEDO BOAT SHUBRICK.



SOME TYPES OF YACHT MODELS.

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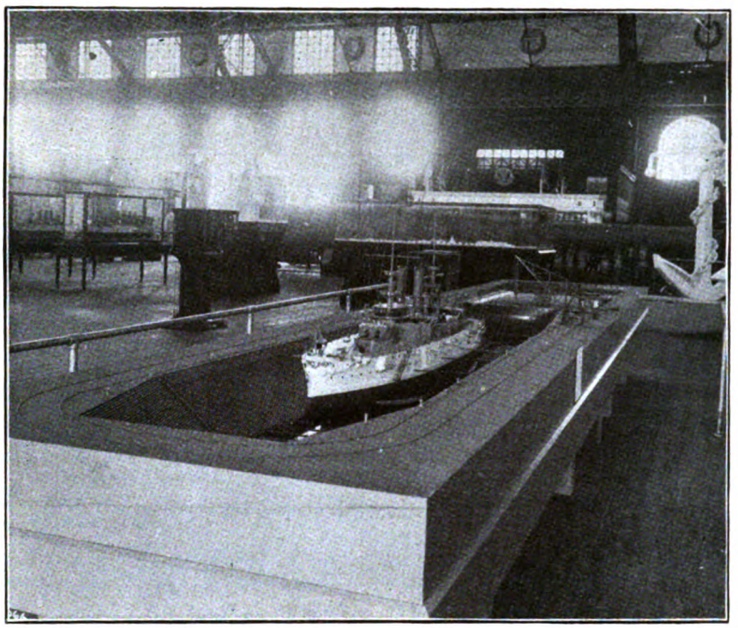
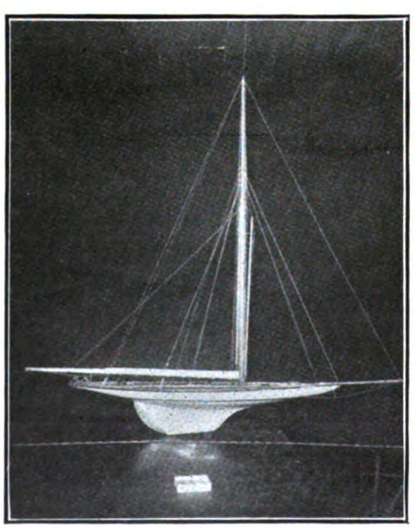


WORKING MODEL OF DRY DOCK.

a turning lathe can be persuaded to do numerous things in addition to its ordinary turning work, and the same remark applies to each separate machine installed. It will be understood, therefore, that the mechanic operating the machines has to be an exceptionally skilled worker, combining a considerable amount of brain work with the skill of his hands.

The ordinary individual who for pas-

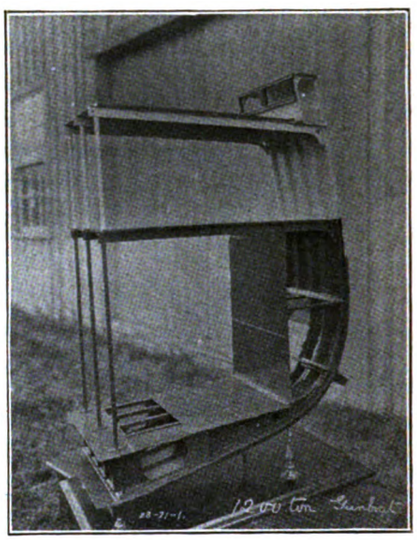


MODEL OF SHAMROCK III.

time or on account of awakened interest tries to estimate the cost of completed models usually finds his figures running more than wild. Not being acquainted with the time taken in fitting each separate part, in polishing and finishing, his wild guesses are excusable. It may interest our readers to know that the recently completed model of the steam yacht Vanadis is valued at about $2,000; the model of the Hudson river steamer Hendrick Hudson, at $3,500; the models of the transport Sherman, at $7,500, the engine installed in the longitudinal section of the transport, one of twin engines, being valued at $300. The model of the Hendrick Hudson is about 8 ft. in length.

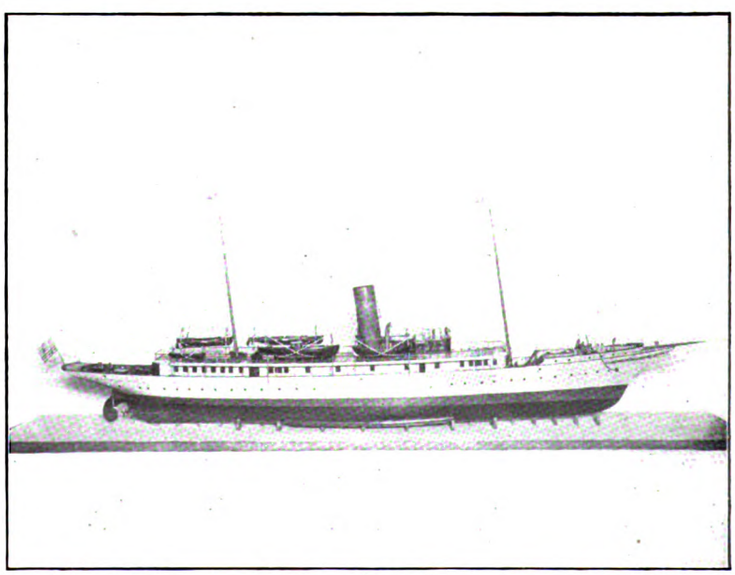
Mr. Boucher for 15 years was in the government employ as draftsman and designer at the Brooklyn navy yard, being transferred from there to Washington, where, for several years, he held a responsible position at the navy yard in the department of construction and repair. Mr. Boucher was always deeply interested in model construction, and his wide experience in the service of the government has proved invaluable to him in the detail work of the models. He had charge of the navy department exhibits at St. Louis and Portland, Ore., many of models shown having been constructed at Washington under his supervision. Within recent years his energies have been devoted to the development of the model-making industry at his workshops in Maiden Lane, New York.

It may interest our readers to learn that plans are nearing completion for the formation of a model motor boat club in New York. In Europe there are many



MODEL OF SECTION OF COMPOSITE GUNBOAT.

such clubs, contests being held yearly for challenge trophies on the lakes of the principal cities. In Paris, where the sport is enthusiastically followed, an annual carnival is held on the lake of the Bois de Boulogne. At this carnival last year



MODEL OF YACHT VANADIS.

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there were 24 starters, the winner being a 4-ft. 6-in. model of the racer Lutece driven by a gasoline engine. During the contest she averaged 6.87 miles an hour.

THE FUTURE CARGO STEAMER.

BY S. J. P. THEARLE.

I am requested to foreshadow the cargo steamer of the future, and by this I understand the proximate and not a remote future. I do not enter cheerfully upon prophetic functions, being well aware of the risk that in a few years hence it may appear that I was utterly wrong in my anticipations. Never to prophesy unless one knows is a safe maxim, and as certainly prudent as that of doing nothing in order to avoid mistakes. If I depart from the path of wisdom by entering the domain of conjecture it is solely to satisfy the demands of the editor. Moreover, it must be clearly understood that I am expressing my own opinions only. Evolutionary processes are of a necessity continuous in their action and in their results. It is only by comparing the conditions of last year, last week, and yesterday with what is seen today that we are able intelligently to forecast the conditions of tomorrow. Tendencies may perhaps be sufficiently distinctive and obvious in their character to enable one to peer still further into the future, but the more remote that future, the less trustworthy is the forecast. We know what the cargo steamer of today is like, and we may be tolerably sure of what will be the characteristics of the cargo steamer of tomorrow, or of even a year hence; but if we venture over an interval of, say, 10 years hence, there will be so much of uncertainty in the materials at our disposal that our conjecture must necessarily have more of the character of a guess than of an intelligent prediction. In speaking of a cargo steamer it must be understood that allusion is made to our old friend the "tramp." Steamers specialized for certain trades do not come under our consideration even when employed wholly in cargo carrying, and not for passenger carrying also. The cargo steamer we have in view is in the "tramp" intended to go anywhere and carry whatever may be waiting for her when she gets there. Now, judging by present tendencies, she will not be any larger than at present. Her size will be principally limited by the depth of water which is generally found available for her at the ports she will have to visit. The ports having a moderate depth of water—say, 20 ft. to 24 ft.—will have more to do with fixing her dimensions than the few large ports which can accommodate vessels of the greatest size and draught. The tramp must be sure of being able to get into as many ports as possible without unduly limiting her size. The larger vessel always works with greater proportionate economy than the smaller one. Our tramp must just strike the happy mean of being able to go to many places for and with cargo and to work with gold average economy. She will therefore range between about 320 ft. and 400 ft. in length, and it does not appear probable that for the world's general cargo carrying trade these limits will in the near future be much exceeded. If the cargo steamer of the less proximate future much exceeds the latter dimension it will be only in consequence of dock and harbor boards having generally increased the depth of water in the ports they control. The type is the next feature to be considered, and here one feels oneself on slippery ground. There are inventive people who have applied their skill to the production of types of vessels which they contend are superior to those which previously existed. There are several forms of steamship design in which the skill and ingenuity of these designers may be seen today, and I certainly do not intend to venture any opinion regarding their relative merits. Nor will I venture to say whether the signs of the times, as I read them, indicate that any of these is the cargo steamer of the future. My survey of the situation and my opinion thereon must be wholly without regard to the merits or otherwise of these rival claimants for public favor. Neglecting, then, what may be styled the special designs, and considering only the normal ones, it appears that for ordinary cargo carrying purposes the poop, bridge, and forecastle type is likely to endure for many years to come; and so strong is the spar-deck steamer of today when compared with the three-deck steamer of 20 years ago, that in cases wherein the existence of a second deck or tier of beams is not felt to be objectionable, the spar-deck steamer will continue to be built. But while this is so, it yet appears to be probable that the great majority of cargo steamers will prefer the roomy hold with unbroken stowage afforded by the one-deck vessel. Hence the one-deck type of a length ranging from 320 ft. to 400 ft., and having a poop, bridge house, and forecastle, seems likely to be the prevalent cargo steamer of the near future. This vessel will be built with deep framing and probably with widely spaced pillars of extra strength supporting strong girders placed under the deck beams and attached intercostally to the deck plating. The design will show an increasing, if regrettable, tendency to dispense with transverse watertight bulkheads. Her masts will cease to serve any other purpose than that of supporting the derricks which load and discharge the cargo, and of carrying signals and lights. The materials of which the vessel will be built for some time yet to come will be mild steel of the same physical qualities as are now being used. Higher tenacity steel will doubtless come by and by, but for this development we have to wait upon the steel makers, who, up to the present, appear to be unable to supply a reliable article of the kind at a moderate cost. When the cheap and reliable steel of high tenacity comes it will be used in building cargo steamers; but its use, while adding to her cargo carrying power, will not materially affect the design of the vessel any more than the transition from iron to mild steel contributed in itself, apart from other circumstances, to modify the steamer of 25 years ago. A few words regarding the machinery of the cargo steamer of the future are necessary to complete this feeble forecast. Steam turbines and internal combustion (oil and gas) engines may possibly by and by be found economically possible and desirable in cargo steamers, but up to the present indications are wanting of a tendency towards either the one or the other. The speed at which the turbine must work, to be economically advantageous, at present precludes its use in the cheaply-driven, low-powered, and comparatively slow tramp steamer. Mechanical difficulties at present operate against the use of internal combustion engines of large size, and other problems await solution before such machinery can be usefully employed for over-sea work. The future may, and probably will, find a solution to all of these. Should that time arrive, the influence of such engines on the form and design of the cargo steamer will not be considerable. She will, however, work more economically and probably at greater speed than at present, and only as regards the conditions for the proper attainment of that speed will her dimensions and form differ from those which prevail today.—*Shipping World*, London.

The Great Lakes Towing Co.'s tug Reliance will be stationed at the Sault this season and the Rescue at Detroit.

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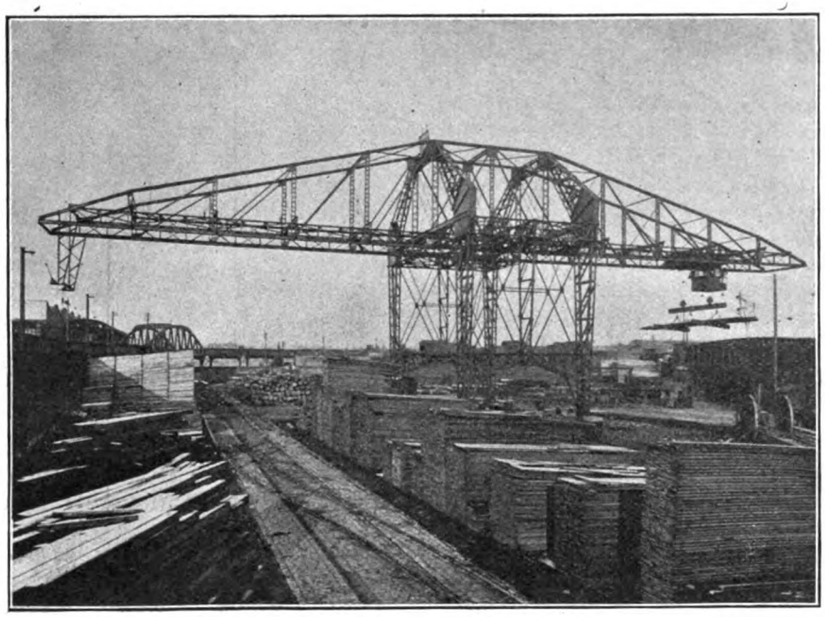
A MAMMOTH CANTILEVER CRANE.

Messrs. C. and A. Musker, engineers of Liverpool, have just erected at the North Mersey goods yard of the Lancashire and Yorkshire railway which adjoins the largest of Liverpool docks, a remarkable crane which has cost about $50,000. It is an imposing structure intended to meet the increasing growth of business and the quick handling and loading of traffic.

The crane is of the cantilever type, and the total weight is about 150 tons.



A MAMMOTH LIVERPOOL CRANE.

It runs on 14 wheels on a track of about 1,620 ft. long, and about 30 ft. wide. Having a clearance height of 30 ft., it can not only lift and stack goods to shortly within that height, but can move up and down the immense goods yard with ease, passing over goods, wagons, and locomotives; and as it has a cross transverse of about 172 ft., it can pick up a load and deposit it at any point within an area of 31,000 square yards. Notwithstanding this very wide field of operations, it only occupies a small floor space. Two motors of 90 H. P. each are provided for lifting and longitudinal traveling respectively, and a 25-H. P. motor for cross traveling, the lifting speed being about 90 ft. per minute; longitudinal traveling about 400 ft. per minute, and cross traveling about 600 ft. per minute. Electric current is obtained from the company's electrified line which runs near by, direct-current at 600 volts being taken from an overhead conductor by means of two ordinary trolley poles, trailing in opposite directions. The total length of the crane is 188 ft., and the total height, 63 ft. The operator travels with the crab and thus has the load always in view, a matter of importance when working amongst timber stacks. Consequently all the controllers for working the motors are placed in the crab cage. The crane legs are placed sufficiently wide apart to allow a 40 ft. log of timber to pass right through from one side of the yard to the other without requiring to be twisted. The Overhead railway which runs for seven miles along the whole length of Liverpool dock is seen on the left of the picture, which has been supplied to us by the builders, Messrs. C. and A. Musker, Ltd., Liverpool.

THE NICHOLSON SHIP LOG.

Messrs. Barrett & Lawrence, of Philadelphia, eastern agents of the Nicholson Ship Log Co., have been awarded the contract to equip the three new U. S. cruisers Birmingham, Chester and Salem with the No. 1 Nicholson Ship Log. This concern has also made shipment of one No. 1 Nicholson Log to Italy, for the new battleship Vittorio Emanuele. The Nicholson Ship Log is rapidly gaining favor with every class of large vessel, as, next to the compass, it is without doubt the most valuable navigating device yet produced. As the shipping companies and governments continue to build more expensive and powerful vessels, it is essential that they should be equipped with the most accurate device known to navigation.

LIMITATIONS UPON SHIP DESIGN.

BY BRYSSON CUNNINGHAM.

The problem of ship design is one which concerns not naval architects and ship builders, but also ship owners, harbor engineers, and port authorities generally. There is a mutual interdependence of all these interests which renders co-operation a most essential proceeding, and, before any important development in naval construction can be put in hand, it becomes necessary to ascertain its bearing in regard to trading facilities and port accommodation.

Now the law of progress demands continual advance in maritime as in other matters, but docks and entrance locks, like the bed of Procrustes, present so rigid a standard of capacity, and are, unfortunately, so restricted in their existing dimensions, that naval architects have been complaining for some time past of want of scope and freedom for developments which they regard as desirable in the interests of the mercantile marine. It has been customary to make the harbor engineer the scapegoat for this state of affairs. But the blame does not rest with him, for he has again urged the necessity of extension works, nor is it altogether fair to charge it upon port trusts and other governing bodies; it is very largely, if not altogether, a financial question, and one which, on consideration, will be admitted to be beset by great and peculiar difficulties.

Dock construction is an expensive affair; but dock alterations and extensions are relatively still more expensive. The lengthening and deepening of entrance locks and graving docks can only be effected, in the majority of cases, at an enormous cost, out of all proportion to the original expenditure, and, even in designing new works, the provision of additional depths and lengths is a matter involving so much extra outlay as to call for most serious reflection. Where the resources of a port are limited, the authorities may well hesitate before incurring heavy additional financial burdens, and they are fully justified in weighing very scrupulously the cost of improvement schemes laid before them.

Still, a policy of excessive caution is not one to be altogether commended. Provision must be made for the future, even where an element of risk and uncertainty is present. Neglect to furnish the requisite facilities for commerce can only result in the decline of the prosperity of the port. Trade is a capricious mistress; she does not always favor localities where

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her interests are most carefully studied, but she invariably abandons those where they are neglected.

A consideration of the representations which have been put forward by eminent ship building authorities shows that it is in regard to available depth of water that the difficulty of modern ship design principally lies. Vessels have increased in length out of all proportion to their draught, and latterly there has been a corresponding enlargement in beam. Increments in length and breadth are likely to continue, but co-extensively therewith and even preliminarily thereto, there should be an advance in draught. And the question engaging the attention of harbor authorities of the present day, are how to provide the additional depth of water, and to what extent the deepening of sills and entrance channels should take place.

It must be obvious that the same standard of depth cannot apply universally. Certain ports are confined to special classes of trade, which render them subject to conditions not obtaining elsewhere.

The deepest draughted vessels of the present time are those of the Cunard and White Star lines. The Mauretania, the Lusitania, the Baltic, the Cedric, the Celtic, and others have loadline draughts ranging between 35 and 37½ ft. These vessels run between Liverpool and New York, and it must be admitted that, considering them as fully loaded vessels, neither of the ports in question can lay claim to that constant accessibility which is the desideratum of a modern port. Until recently the entrance channel to New York harbor did not afford a greater depth than 30 ft. at low water, while over the bar of the Mersey the margin is only 28½ ft. at low water of spring tides. It is, of course, true that, in the case of the Mersey, the great tidal range of 30 ft. speedily produces an amelioration, and that the occasions of delay to shipping are limited to a few hours once or twice a fortnight. But delay in any degree is incompatible with the conditions of modern trade, and the authorities on both sides of the Atlantic have recognized this fact. New York is to have a new 40 ft. channel (of which 35 ft. is reported to be achieved), and the Mersey bar is to be lowered as many feet as can be effected by a new dredger which is the most powerful in the world—of 10,000 tons capacity, and capable of working 10 ft. deeper than any of its predecessors.

Apart from liners of foremost rank, the most important class of vessel in the mercantile marine is that engaged in general trade, and drawing from 25 to 30 ft. of water. Such are the steamships which ply between Great Britain, the colonies, and the far east. A large proportion of them come to London, where they discharge in the various docks. The Tilbury dock has always been able to accommodate vessels of considerably over 30 ft. draught, and this is likewise true in less degree of the Albert dock basin. But the entrance channel to the Thames has not invariably provided means of access, and the Leigh Middle Shoals have restricted the available depth at low water to about 24½ ft. The Thames Conservancy now have the matter in hand, and the low-water channel is to be deepened to 30 ft., at least as far as Tilbury, and possibly (ultimately) as far as Galions.

The few foregoing instances selected from among the principal ports of the world conclusively demonstrate that the present is no time for slackening effort on the part of those who desire to maintain the harbors of this country in a state of efficiency and advancement. There are now in existence no fewer than 110 vessels with tonnage of 10,000 and upwards, of which eight exceed 20,000 tons. These represent vessels of from 500 to 790 ft. in length, 60 to 88 ft. in breadth and 29 to 37½ ft. in draught. They constitute a class which in the opinion of the ship owner is economical to work, and in the opinion of the naval architect is perfectly feasible to construct and even to enlarge upon. They are constantly receiving fresh accessions, and any port which aspires to the front rank must adapt itself to their ready reception and despatch. It cannot be too strongly urged that whatever measures are necessary to this end should be put in hand forthwith. Dock and harbor constructional operations are difficult and sometimes hazardous. They cannot be executed at a moment's notice, and many long months must often elapse before they can be completed so as to be ready for use. In the meantime the world moves on; fresh necessities arise and further demands are made. A prudent foresight which anticipates the need of coming years is the wisest, the best, and, in fact, the only policy.

The Corrigan-McKinney fleet, comprising the steamers Polynesia, Australia and Amazon will hereafter be operated by the Australia Transit Co. which has been formed for that purpose. Capt. J. W. Brion will, as formerly, manage the fleet.

VALUE OF STEEL CORPORATION PROPERTIES.

An audit of the properties of the United States Steel Corporation appears in the June number of *Munsey's Magazine,* prepared and written by Frank A. Munsey, to whom the Steel Corporation lent every possible aid. Taken in connection with the figures submitted by Judge E. H. Gary in an interview with James B. Morrow on April 13, 1908, Munsey's figures are interesting. Munsey figures that the assets of the company are worth $1,782,187,383, or $311,283,272 in excess of the total capitalization of the company. Judge Gary says that "the actual cash value of our property is considerably more than $2,000,000,000." According to Munsey, the ore mining and timber properties are valued at $738,866,017; Judge Gary in his interview says that "the valuation of the ore owned by the Steel Corporation is $1,200,000,000." The Munsey valuation of the coal and coke properties is $142,839,779; Judge Gary holds that the value of the coal lands is $120,000,000, and of the coke ovens and coke equipment $100,000,000, or, the total for the coal and coke properties is $220,000,000. Munsey finds the manufacturing properties, exclusive of the Gary, Ind., plant, worth $382,248,897, and the Gary plant expenditure up to Jan. 1, $24,063,388; sundry real estate, dock facilities, railway terminals, employes' dwellings, etc., aggregate $6,694,973; the Tennessee Coal & Iron Co., $50,000,000, making the total valuation of manufacturing properties, according to Munsey's estimate, $463,007,258. Judge Gary on this point said: "Our physical property, that is, our mills and furnaces, could not be duplicated for less than $400,000,000." Munsey finds the net liquid assets Dec. 31, 1907, are $261,789,885. In Munsey's estimate the Tennessee Coal & Iron Co. is a separate item at an estimated value of $50,000,000, which is somewhat more than the Steel Corporation paid for it, but its chief value lies in its coal and ore properties, which are estimated as worth $100,000,000 and $105,000,000, respectively. Neither, in the Munsey estimate, is included the contract of the United States Steel Corporation for the Great Northern ores listed as an asset.

The tug Owen, owned by the Trotter Wrecking & Towing Co., is being rebuilt at Amherstburg and will be used in conjunction with the new wrecking steamer J. E. Mills.

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Factors of Safety in Marine Engineering*

BY PROF. JOHN OLIVER ARNOLD, OF SHEFFIELD UNIVERSITY.

On the vital importance of the subject dealt with in this paper it is obviously unnecessary to dilate, and in dealing with it the author will endeavor to sustain the somewhat difficult, delicate, but, unfortunately, necessary part of acting as a sort of connecting link between engineers and metallurgists. He fully expects some adverse criticism from the ranks of the first-named, since it will be his duty to deny the truth of dangerous dogmas which have to a considerable extent, in connection with engineering calculations, held the field since 1871.

In discussion upon matters such as those dealt with in this paper, engineers have occasionally insisted on the great importance of basing all calculations on the elastic limits of the materials used in construction; but, speaking generally, such contributors to debate have been somewhat akin to finger-posts, which point out the way but never travel by it. Broadly speaking, engineers always base their calculations on the maximum stress (often absurdly called the "breaking strain")† capable of being endured by the metal employed. The reasons for this procedure are:

(1) The maximum stress is a value capable of accurate and rapid measurement on the static machines used in ordinary works practice.

(2) It is more or less an accepted canon in engineering faith that the maximum stress is really an indirect measure ment of the elastic limit in the ratio of about 2:1. There is no doubt that in the majority of cases the rule just specified is approximately true, but it is also equally true that in a relatively small, but, nevertheless, extremely important number of instances, this widely accepted datum is hopelessly inaccurate. So far as the author has been able to ascertain, factors of safety in marine and other engineering practice are calculated as follows:

Firstly.—In a rough-and-ready fashion by taking care to subject the material of construction only to a working stress varying according to circumstances from about one-quarter to, say, one-tenth of the maximum stress of being endured by the material.

Secondly.—In scientific engineering a more elaborate course of procedure obtains. Let 1 = the maximum stress of the material and n = the factor of safety, then $\frac{1}{n}$ = working load. The factor n is obtained as a product of several sub-factors, which may be designated as a, b, c and d. Sub-factor a is the ratio of the elastic limit to the maximum stress, and is almost universally, in connection with mild structural steel, assumed to equal 1½ to 2½. Sub-factor b is a variable, dependent on the character of the stress to which the material is subjected, and, broadly speaking, is based on the classical work published by Wohler in 1871, which indicated that metals subjected to rapidly varying stresses, will ultimately break under a load within the elastic limit.

TABLE I.*

SHOWING DEVIATION OF FACTORS OF SAFETY FROM THE COMPONENT SUB-FACTORS.

Showing Derivation of Factors of Safety from the Component Sub-Factors.

Type of purpose for which the steel is to be used.	Nature of sub-factors involved: a (Elasticity).	b (Wohler Phenomenon).	c (Rapidity of Load).	d Unknown Contingencies).	n = a×b×c×d = Factor of Safety.
Boilers	2	1	1	2¼—3	4.5—6
Double-acting connecting rod	1.5—2	3	2	1.5	13.5—18
Single-acting connecting rod	1.5—2	2	2	1.5	9—12
Shaft carrying propeller	1.5—2	3	1	1.5	6.75—9
Steel cast wheel rim	2	1	1	4	8
Steel castings	2	1	1	2	4
Oil tempered steel	1.5	1	1	1.5	2.25
Nickel steel	1.5	1	1	1.5	2.25

*The figures in this table were kindly compiled for the author by Mr. J. W. Kershaw, M. Sc., of the Engineering Department of Sheffield University.

Taking three typical cases, we have:

(1) A steady load, as in bridges and boilers, in which $b = 1$.

(2) Loads varying between zero and a maximum as in single-acting connecting rods, where $b = 2$.

(3) Alternating loads, where stress varies from tension to compression, as in a double-acting connecting rod, where $b = 3$.

Sub-factor c is a variable dependent upon the rapidity with which the stress is applied. A sudden load is supposed to stress the material to twice the extent of one gradually applied, therefore, $c = 1$ for a steady load, 2 for suddenly applied load, and, say, 3 for load including impact. Sub-factor d is used as a margin for unknown conditions and contingencies, and is a variable ranging from 1½ to 3. Table I embodies concrete examples of the application of the foregoing sub-factors.

In 1895 the author read before the Institution of Civil Engineers a paper on "The Influence of Carbon on Iron," which engineers have apparently considered of small practical value. After an interval of a dozen years the author again ventures to call the attention of marine engineers in particular to the remarkable statical test data published in that paper, and also to show that some of the sufficiently disconcerting mechanical facts embodied therein, were considerably understated. In connection with the main points at issue, namely, the properties of more or less mild steels connected with structural materials of engineering, it is necessary to quote only a fraction of the data just referred to, namely, that concerned with steels ranging in carbon from about 0.1 per cent to 0.4 per cent. The steels investigated were submitted to tests in two widely differing micro-chemical conditions, produced by two widely diverse rates of cooling. These two conditions may be specified by the terms, "normalized" and "annealed," or, to be strictly accurate, "annealed to death." The tabulated results of these particular steels are now reproduced from the proceedings of the Institution of Civil Engineers in Tables II and III of the present paper. The requisite thermal definitions are as follows:

The normalized steels were heated to a bright red or orange, say, 950° C., and were spontaneously cooled in air. The annealed samples were maintained at a similar temperature for about 72 hours, and were then allowed to cool to milk warm during an additional 100 hours.

TABLE II.

NORMALIZED STEELS.

Steel No.	Carbon, per cent.	Elastic limit, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation, per cent., on 2 in.	Reduction of area, per cent.
1	0.08	12.19	21.39	46.6	74.8
1½	0.21	17.08	25.39	42.1	67.8
2	0.38	17.95	29.94	34.5	56.3

TABLE III.

ANNEALED STEELS.

Steel No.	Carbon, per cent.	Elastic limit, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation, per cent., on 2 in.	Reduction of area, per cent.
1	0.08	8.82	18.34	52.7	76.7
1½	0 21	9.02	21.25	42.3	65.7
2	0.38	9.55	25.02	35.0	50.6

In connection with factors of safety the important columns in the forego-

*Read at Institution of Naval Architects.

†The "breaking strain" is the total elongation in inches, and yet one often sees report sheets expressing this linear dimension in tons per square inch.

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ing tables are those originally alleged by the author to be the elastic limits of the three steels in the normal and annealed conditions, but it must now be confessed that the columns headed "elastic limit" should have been headed "yield point, or apparent elastic limit." The author's subsequent experience has shown that the difference between the yield point and the true elastic limit in normal structural steels is about 1¼ and in the over-annealed steels about 3½ tons per sq. in. In view of these facts, the approximately correct figures are shown in the following table:

TABLE IV.

Steel No.	Carbon per cent.	Condition of steel	Approximate true elastic limit, tons per sq. in.
1	0.08	Normalized	10.44
1½	0.21	Normalized	15.33
2	0.38	Normalized	16.20
1	0.08	Annealed	5.32
1½	0.21	Annealed	5.52
2	0.38	Annealed	6.05

The maximum stress curves of the normal and the elastic limit curves of the normal and annealed steels are plotted in Fig. 3 (Plate II), and will be dealt with later.

As bearing upon the results last tabulated, having reference to forged, and forged and annealed steels, it will be well to call attention to a result registered by an annealed steel casting, and published by the author about 10 years ago during an extension lecture given at the East End of Sheffield. This result, which was received with profound skepticism (in which the author was at the time inclined to share), was as follows:

TABLE V.

Condition of steel.	Elastic limit, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation, per cent., on 2 in.	Reduction of area, per cent.	Bending test.
As cast	17.6	25.5	5.0	5.6	21° broken
Annealed	7.4	24.3	32.5	37.7	180° unbroken

This casting contained 0.4 per cent carbon, 0.26 per cent silicon, 0.10 per cent manganese, together with low sulphur and phosphorus. The figures 7.4 have reference to the yield point, *hence the true elastic limit of this material was really approximately 3.9 tons per sq. in.* An elastic limit so astoundingly low as about four tons per sq. inch justifies the author in putting forward as a tentative hypothesis, that mild steel by over-annealing may actually (like pure copper) have practically *no elastic limit*, that is to say, at any point above the zero of a stress-strain diagram the metal may assume plastic, as distinct from elastic, deformation. In such a case, the factor of safety must be, theoretically, almost infinitely great to prevent the ultimate fracture of the steel. An ordinary stress-strain diagram of steel, the co-ordinates of which are, of course, stress in tons and strain in inches, may be divided into five ranges (see Fig. 1). Range A is a very

MILD STEEL STRESS-STRAIN DIAGRAM.—TYPE I.

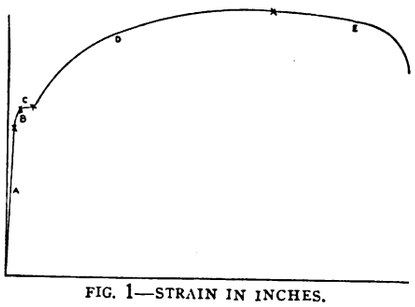

FIG. 1—STRAIN IN INCHES.

steep straight line, along which the material is assumed to be perfectly elastic, and within which equal increments of stress produce equal increments of strain, such strain being essentially elastic deformation. This line has been named the "range of proportionality," and its upper end is supposed to mark the true elastic limit of the metal under test.

Range B is a short and variable curve, the beginning of which touches the range of proportionality, and the end merges into range C.

Range C is often a short, nearly horizontal, line marking the yield point or apparent elastic limit.

Range D is a variable curve, the highest point of which marks the maximum stress.

Range E is a falling curve, the lowest point of which measures vertically the breaking stress, and horizontally the breaking strain, or total elongation in inches; but in connection with

MILD STEEL STRESS-STRAIN DIAGRAM.—TYPE II.

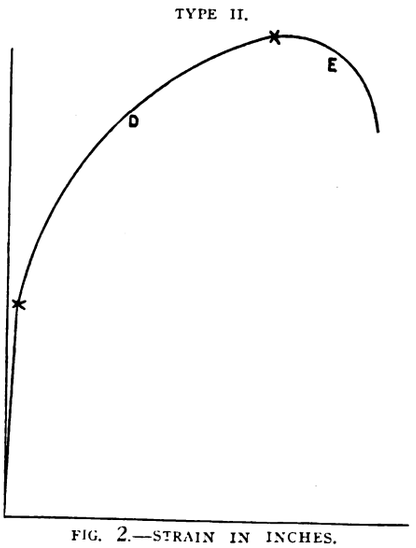

FIG. 2.—STRAIN IN INCHES.

drastically annealed structural steels, the second type of curve (see Fig. 2) is often registered, which has only three of the ranges observed in the first diagram, namely, range A, an alleged range of proportionality; D, a flowing curve extending from the end of the supposed straight line to the point of maximum stress; E, a curve beginning at the point of maximum stress and ending at the breaking stress and maximum strain point.

With reference to the type of curve exemplified in Fig. 2, in view of the enormously disproportionate dimensions of the measured co-ordinates of a stress-strain diagram, namely, stress in tons per square inch and strain in, say, 1/10,000 in., it is hardly an unreasonable question to ask, is range A really a proportional line, may it not be a curve from zero? or contingently, to vary the question, if this be so, where is the elastic limit, if any, of the material?

Referring to Fig. 3 it will be noted:

(1) That the observed maximum stress curve shows, in normal mild steels almost free from manganese, as the carbon falls from about 0.4 to 0.1 per cent, that, with a constant factor of safety of 1 in 6, the working stress falls from 5 to 3.5 tons per square inch.

(2) That the approximately observed elastic limit curve shows that in normal steels the assumed factor of safety of 3 is really exceeded, ranging from 3.6 to 3.63.

(3) That, assuming an engineer had calculated his factors of safety on a basis of 6 to 1 on the maximum stress, involving a factor safety of at least 3 to 1, on the elastic limit of the normal, then, if previous to delivery the steel had been (with the best intentions) over-annealed, the approximate elastic limit, instead of averaging 3 or upwards, will average less than 1½.

The absurdity of the foregoing hypothesis is mitigated only by the fact that, within the author's knowledge, such cases have occurred in actual practice. The curves plotted in Fig. 3 (plate II) probably represent in concrete tonnage the extreme possibilities of over-annealing, because of the practical absence of manganese from the series dealt with. In practice, open-hearth steels generally contain from 0.4 to 0.8 per cent of this element, which considerably modifies the action of over-annealing in its excessive lowering of the elastic limit. Therefore, the author advocates the percentage last named.

The startling micrographic changes brought about by over-annealing struc-

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tural steels are exhibited at their maximum (again owing to the low manganese present) in Fig. 4 (Plate I). It has reference to the steel containing 0.38 per cent of carbon. The left half micrograph shows a normalized steel, consisting of a white sectional ground mass of ferrite or iron (lightly etched, so as not to develop the junction lines of its allotrimorphic crystals) overlaid with dark etching normal pearlite, consisting of 87 per cent iron, through which is evenly distributed in ill-formed laminae 13 per cent of carbide of iron Fe_3C. The right-hand half section shows the over-annealed steel in which the carbide Fe_3C has sharply segregated, passing partly into parallel lines characteristic of Sorby's laminated pearlite and partly into masses marking the commencing decomposition of laminated pearlite into cementite and ferrite. The texture of the over-annealed metal is much coarser than that of the normal steel. The author has found that, roughly speaking, the true elastic limit of pure normal pearlite is about 23 tons per square inch, whilst that of laminated pearlite is only about 13 tons per square inch. He has also observed that the true elastic limit of pure normal ferrite is about 10 tons per square inch, while the true elastic limit of over-annealed ferrite is about 5 tons per square inch. For manganiferous pearlite and ferrite the foregoing figures are considerably raised.

FAILURE OF FACTOR OF SAFETY CALCULATIONS IN ACTUAL PRACTICE.

In describing such failures it would obviously be improper for the author to specify particular cases. He therefore gives a typical example, which is really the mean result of several cases he has been from time to time commissioned to investigate. This average case includes about 20 careful determinations each, of the maximum stress and elastic limit of the steels involved, which were for the most part in the form of hollow shafts, ranging between 22 in. and 25 in. in diameter. The main static results of the "pooled" tests are embodied in Table VI.

TABLE VI.

True elastic limit, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation per cent on 2 in.	Reduction of area per cent.
8.5	28.5	30.5	52.5

All the shafts involved had evidently been over-annealed, not necessarily in the sense that they had been overheated, but rather that they had been kept for too long a time in a low red range of temperature. It is quite probable that in designing these shafts the material was supposed to have a maximum stress of 30 tons per square inch and an elastic limit of at least 15 tons per square inch, and that the factor of safety was to be, say, 7 to 1, this is equivalent to a working stress of about 4.3 tons per square inch. The intention and actual achievement of our abstract designer are embodied in Table VII.

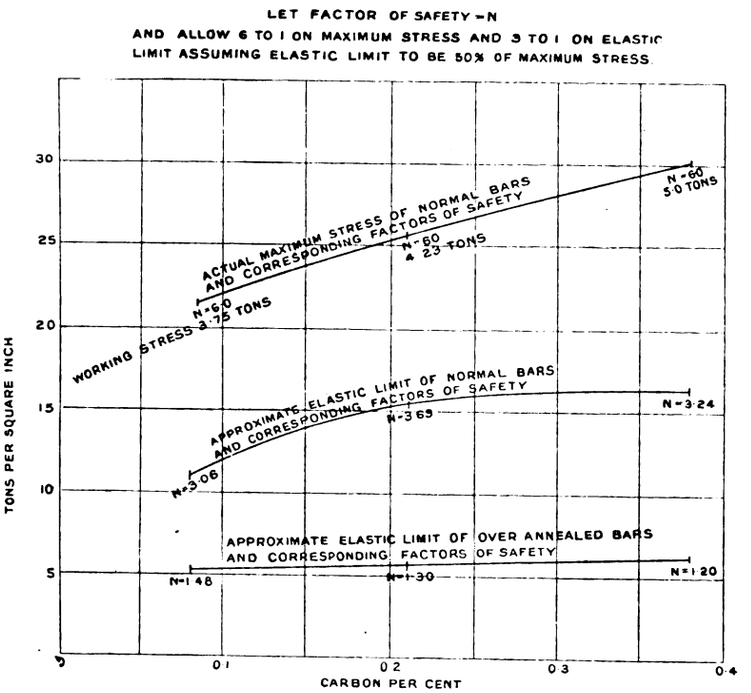
TABLE VII.

Factor of safety calculated on assumed maximum stress.	Factor of safety calculated on actual maximum stress.	Factor of safety calculated on assumed elastic limit.	Factor of safety calculated on actual elastic limit.
7.0	6.65	3.5	1.9
Adequate.	Adequate.	Adequate.	Quite inadequate.

The shafts, of which the above mean table is typical, all fractured in use, and the result in the last compartment of the table distinctly understates the worst case involved therein.

Fig. 3.

CURVES SHOWING POSSIBLE ERRORS IN CALCULATING FACTORS OF SAFETY ON OVER ANNEALED PURE CARBON STEEL


LET FACTOR OF SAFETY = N
AND ALLOW 6 TO 1 ON MAXIMUM STRESS AND 3 TO 1 ON ELASTIC LIMIT ASSUMING ELASTIC LIMIT TO BE 50% OF MAXIMUM STRESS
TONS PER SQUARE INCH
CARBON PER CENT
ACTUAL MAXIMUM STRESS OF NORMAL BARS AND CORRESPONDING FACTORS OF SAFETY
N=6·0
WORKING STRESS 3·75 TONS
N=6·0
4·23 TONS
N=6·0
5·0 TONS
APPROXIMATE ELASTIC LIMIT OF NORMAL BARS AND CORRESPONDING FACTORS OF SAFETY
N=3·06
N=3·69
N=3·24
APPROXIMATE ELASTIC LIMIT OF OVER ANNEALED BARS AND CORRESPONDING FACTORS OF SAFETY
N=1·48
N=1·30
N=1·20

ON GHOST LINES

Annealed large shafts nearly always exhibit decarbonized ghosts. In order to avoid scientific confusion, and any appearance of encroaching on the domain of an eminent scientist, it may be well at once to state that "ghosts" of steel are invariably materialized and dangerous, and in the author's experience (which, however, is quite subject to revision) the sequence of their materialization is as follows:

In a big ingot, irrespective of the liquated and scrapped upper third, in parts of which the phosphorus, for instance, may exceed 1 per cent, there is always more or less a segregation of the mobile elements, carbon, sulphur, and phosphorus, to a series of centers. Investigations on the "Diffusion of Elements in Iron," carried out at the Sheffield University College, and published in the *Journal of the Iron and Steel Institute,* No. 1, 1899, indicated the mobility of carbon to be about five times as great as that of sulphur, phosphorus, and nickel. The upper micrograph in Fig. 5 shows a dark etching nodular segregation area. This consists of iron containing an undue proportion of (*a*) an isomorphous mixture of the double carbides of iron and manganese (x Fe_3C, y Mn_3C); (*b*) dissolved phosphide of iron (Fe_3P); (*c*) small segregated irregular globules of sulphide of manganese (MnS). On forging the ingot the angular or martensitic structure is broken up, whilst the nodular segregate is drawn out into a dark etching rod (see also micrograph Fig. 5, Plate I). In such a forging the elongated segregation, which is relatively hard, is in turning operations jumped by the tool, leaving in faint relief a relatively white line, hence the turner's somewhat far-fetched name "ghost" During prolonged cooling at a low red heat, the carbonized ghost becomes decarburized, the dissolved phosphide of iron seeming to expel the hardenite (transformed pearlite) to the edges of the ghost line, the final product be-

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ing the decarburized ghost line, as exemplified in Fig. 6. Here the ghost has become essentially a broken and irregular cylinder of pearlite, filled with pale brown-etching ferrite containing emulsified phosphide of iron, through which is scattered short rods of dove-gray sulphide of manganese.

DYNAMIC OR KINETIC TESTING IN ITS BEARING ON FACTORS OF SAFETY.

The pioneer, valuable and extensive researches, published by Wöhler in 1871, having reference to alternating stresses, both distributed and at a maximum on the skin of metals, have deservedly ever since largely influenced engineering design with reference to factors of safety; but it must be remembered that Wöhler was not a 20th century steel metallurgist, and that some of his supposed disciples have made and acted upon deductions from his experiments not authorized by more thoughtful confirmers and exponents of his work. For an instance of this, the following extract from an American book on steel may be quoted:

"There are people even now who would rather have their forgings made of a mild steel which is weak than of a high carbon steel which is strong, simply because the old ideas are not yet eradicated from their minds. Tests were made at the government testing bureau at Watertown by rapidly bending bars forward and backward within their elastic limit with the following results, and these have given engineers an idea of the comparative endurance of wrought iron and steel in such service as that to which the crank pins, shafts, etc., are subject."

TESTS OF STEEL UNDER REPEATED STRESSES.

Under a fiber stress of 40,000 pounds per square inch.

Wrought iron breaks after 50,000 alternations of stress.
0.15 per cent carbon steel breaks after 170,000 alternations of stress.
0.25 per cent carbon steel breaks after 229,000 alternations of stress.
0.35 per cent carbon steel breaks after 317,000 alternations of stress.
0.45 per cent carbon steel breaks after 976,000 alternations of stress.

To readers who, like the writer of the above extract, are imperfectly acquainted with the researches and calculations of Wohler and other competent experimenters who have subsequently confirmed them, the information given might mean (if it means anything) that an engineer may replace a wrought iron crank pin of, say, 19 in. sectional area with a pin of 0.45 carbon steel, only 1 in. in square area, which is absurd.

One of the most complete of Wohler's experiments, and probably the most thoughtful and judicious commentary thereon is to be found in Prof. Unwin's work on "The Testing of Materials of Construction." The term "Fiber Testing" is, however a complete misnomer, since wrought iron and mild steel are now well known to be crystalline bodies, and the only "fibers" connected with them are, respectively, streaks of slag and sulphide of manganese. Perhaps the most valuable of Wohler's alternating stress tests were carried out in the following manner, shown diagrammatically in Fig. 7 (Plate II). B is a rotating test bar firmly inserted in a die D, the stress being applied (diagrammatically) by the weight W. The theoretical cycle of stress changes as the bar rotates as shown in the lower diagram of Fig. 6 (Plate I). M T*s* is the point of maximum skin tension or + stress, dying away to nothing at Z, then passing into compression stress, reaching a maximum skin compression or — stress at M C*s*. This — stress dies away to zero at Z', when the point again passes into + stress, once more reaching a maximum at M T*s*. The author selects from Wöhler's work three of the sets of experiments quoted by Unwin. The first set has evident reference to wrought iron, having statically an average maximum stress of 21.3 tons per square inch, associated with an average elongation of 19.8 per cent, the figure last named having probable reference to a parallel length of 8 in. The second set is said to have reference to "homogeneous iron," but probably represents mild steel or ingot iron, having a mean maximum stress of 28.2 tons per sq. in. in association with an elongation of 20.8 per cent on 8 in. The third set is designated as Krupp's "cast steel axles," registering statically a mean maximum stress of 46.4 tons per sq. in., with an elongation probably on 8 in. of 16.7 per cent. This is presumably a crucible steel containing about 0.6 per cent carbon.

With reference to the first two experiments in Set I and to the first three experiments in Set II, it appears almost certain that in these five tests the bars were stressed well beyond their elastic limit and were hence also plastically strained.

AUTHOR'S ALTERNATING STRESS TEST.

In July, 1905, J. T. Milton, chief engineer surveyor to Lloyds Register of Shipping, read before the Institution of Naval Architects a paper on "Fracture in Large Steel Boiler Plates." In that paper Mr. Milton quoted from reports made to Lloyds committee on the application of a new modification of Wöhler's method devised by the author for testing some large boiler plates, which had split under the hydraulic test. At that time the method had only just emerged from the experimental stage, but had proved beyond all doubt that a piece of the faulty boiler plate, 12 in. by 6 in. by 1 in., which gave satisfactory static tests, good chemical analyses, and was identical all over in micro-structure, exhibited astounding variations in the resistance of its different parts to alternating stress, the most brittle bar having a resistance to rupture less than one-fifth of that registered by the best test recorded, during trials on 32 bars. The author's original idea in devising this test was to

WÖHLERS EXPERIMENTS ON BARS SUBJECTED TO REPETITIONS OF TRANSVERSE STRESS (ROTATING BARS) BETWEEN EQUAL AND OPPOSITE LIMITS OF STRESS.

No. of Bar.	Material.	Stress applied in tons per sq. in. Maximum.	Minimum.	Range of stress in tons per sq. in.	No. of repetitions before fracture.
		SET I.			
1		+15.3	—15.3	30.6	56,430
2		14.3	14.3	28.6	99,000
3		13.4	13.4	26.8	183,145
4	Iron for	12.4	12.4	24.8	479,490
5	axles	11.5	11.5	23.0	909,840
6	Phoenix Co.	10.5	10.5	21.0	3,632,588
7		9.6	9.6	19.2	4,917,992
8		8.6	8.6	17.2	19,186,791
9		7.6	7.6	15.2	132,250,000*
*Not broken.					
		SET II.			
24		+23.9	—23.9	47.8	2,375
25		22.9	22.9	45.8	4,986
26		21.9	21.9	43.8	11,636
27		18.2	18.2	36.4	31,586
28	Homogeneous iron.	16.3	16.3	32.6	94,311
29		14.3	14.3	28.6	161,262
30		13.4	13.4	26.8	464,786
31		12.4	12.4	24.8	636,500
32		11.5	11.5	23.0	3,930,150
		SET III.			
33		+20.1	—20.1	40.2	55,100
34		17.2	17.2	34.4	127,775
35		16.3	16.3	32.6	797,525
36	Krupp's cast steel axles.	15.3	15.3	30.6	642,675
37		15.3	15.3	30.6	1,665,580
38		15.3	15.3	30.6	3,114,160
39		14.3	14.3	28.6	4,163,375
40		14.3	14.3	28.6	45,050,640

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bring Wöhler's method into practical works use by reducing the time occupied in making a test from hours to seconds. The author argued that if the tests, instead of being made (as is general) within the elastic limit, were always made just beyond it, the results would quickly reflect the liability to fracture within the elastic limit, under stresses applied for a very long period. But it was found that the test predicted liability to fracture from causes altogether apart from Wöhler's fatigue phenomenon, and registered potential brittleness, which the Wöhler test not only failed to detect, but emphatically pronounced to be absent. The left-hand sketch of Fig. 8 shows the nature of the author's tests. B is the test piece, ⅜-inch diameter and 5 or 6 in. long. It is gripped in the die D, and the stress is applied by the strokes of the slotted plunger P P. The standard conditions adopted for general works practice are: A rate of alternation of 650 per minute, a distance of 3 in. from the zero of stress (the striking line on the radius of the plunger) and the plane of maximum stress (the top of the die line).

FIG. 4.

The deflection at the zero of stress is ⅜-in. each side, ensuring a stroke of the plunger P P in the direction indicated by the arrow, the point M T*ss* indicates the point of maximum tensional stress and plastic strain, whilst the point M C*ss* indicates the point under the maximum compressional stress and plastic strain. The right-hand diagram in Fig. 8 (Plate II) shows the alternation of the stress-strain lines in the author's test. In the upper circle, with the stress in the direction of the arrows, the point M C*ss* is the maximum of compression, and the point M T*ss* is under the maximum tension stress, the line Z being the fixed zero of stress. In the lower circle, representing the reverse stroke of the plunger, the stresses on the given points have respectively changed from — to + and from + to —. It will be seen that in this test the points of + max. and — max. stress, although alternating, are fixed, as is also the zero line of stress; whereas in the Wöhler bending test a given point passes from + max. to zero, from zero to — max., from — max. to zero, and from zero again to + max., thus completing the cycle. The author's test was frequently found to give unexpected information of considerable value in determining, not to say the homogeneity, which in such connection is an absurd term, but the evenness of the texture of a steel as regards the crystallization of its ferrite and the distribution of its pearlite and sulphide of manganese. It should, however, be remembered that a steel with unsatisfactory physical properties — in other words, a steel of bad quality— may nevertheless be even in texture, while conversely a steel of uneven texture may as a mass be of good quality. The circles forming the upper diagrams of Fig. 9 indicate three types of texture to be observed in mild steels. The direction of the tension stresses and the original points of maximum stress are indicated by the arrow heads. Circle No. 1 represents a fracture of a steel of very even texture, in which fracture has commenced almost simultaneously at exactly opposite points on the skin of the test piece, and proceeded at identical rates inwards, meeting on a line indicating the theoretical zero of stress. The area of metal last to fracture is a strip which breaks in tension under the last strokes of the plunger, leaving a gray line distinct in appearance from the two half-circles constituting the main fracture; thus, as in circle 1, this line is registered in the middle of the bar and at right angles to the direction of stress. In circle 2 is represented the fracture of a bar of very uneven texture, in which rupture had commenced on the right-hand skin considerably before the metal began to break on the left-hand skin, so that the gray line, showing a final tensional fracture, bisects the left-hand semi-circle of the bar, but, as in case 1, is still at right angles to the direction of stress. Circle 3 shows a case in which fracture begins at the right-hand skin before the higher quality of the steel on the left-hand skin began to rupture, but the fracture had proceeded in a direction not at right angles to the line of stress but at the angle indicated by the line of final fracture in circle 3. It may be remarked that evenness or unevenness in texture as indicated by the position and angle of the final line of fracture has been found to be persistent along a test bar for several inches. The lower diagram of Fig. 9 indicates how the steel may be so uneven in mechanical quality as to break, say, ¼ in. above the plane of maximum stress. This, of course, means that, had the plane of fracture been coincident with the plane of maximum stress, that is,

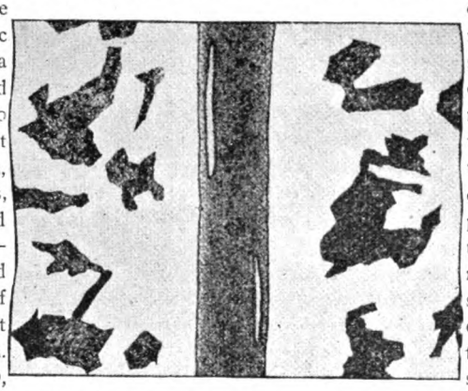
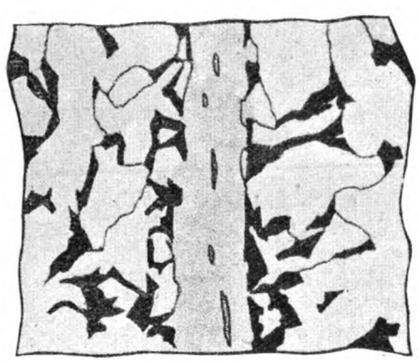


FIG. 5—CARBONIZED GHOST IN MANUFACTURED FORGING. MAGNIFIED 125 DIAMS.



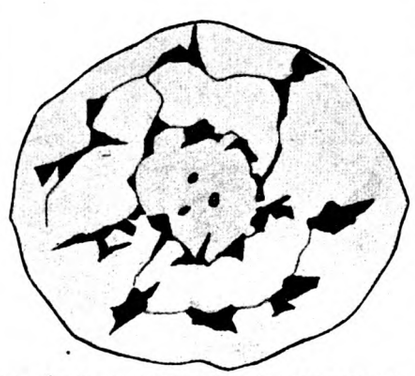


FIG. 6—SECTIONAL PLAN AND ELEVATION OF DECARBONIZED GHOST LINE IN ANNEALED FORGING. MAGNIFIED 37½ DIAMS.

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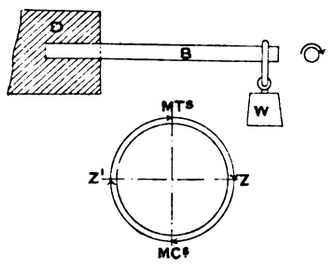
level with the face of the die, the number of alternations endured would have been sensibly less, and this + error may be approximately corrected by setting out a diagram like the lower sketch in Fig. 9. M is the line of maximum stress, Z the zero of stress. Draw a line along the plane of rup-

Fig. 7.

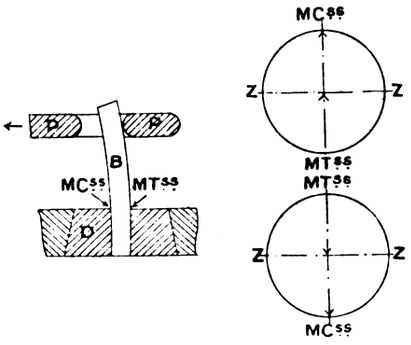
DIAGRAM SHOWING NATURE AND STRESS-CYCLE OF THE WOHLER TEST.



ture parallel with the plane of maximum stress, then at any convenient angle draw a line from the zero of stress to the plane of maximum stress, on the point of intersection erect a perpendicular reaching the plane of rupture. Let the line x T be proportional to the alterations endured, then the result which would be registered, had the fracture taken place on the plane of maximum stress, will equal x T $- x$ y, y being the point of intersection of the angular line with the plane of rupture. The author here hastens to admit that theoretically the Wöhler test is perfect, while that of the author is theoretically hopelessly wrong, since it reproduces no known condition in engineering practice, nevertheless in many cases this test predicts the liability of material to fail in

Fig. 8.

DIAGRAM SHOWING NATURE AND STRESS STRAIN LINES IN AUTHOR'S TEST



practice when the Wöhler test would confidently indicate that the metal was reliable. This apparently improbable enunciation, the author will presently prove experimentally by results obtained on unknown metals, over the preparation of which the author had no control, and distinguished from each other at the time the tests were made only by certain letters and numbers. As comparative bending tests made by the method of Wöhler and that of the author accumulated, it became evident that the former test was merely a reflection of the elastic limit; thus certainly reflecting danger of fracture under excessive stresses, but insidiously concealing the danger from other causes, which determine fractures generally attributed to fatigue. In fact, no matter how dangerously brittle the steel may be from chemical or physical causes, if such causes have co-produced a high elastic limit, the Wöhler indicates the steel to be quite safe if stressed well short of that limit, when, as a matter of practical fact, it is inevitable that the steel must suddenly rupture sooner or later under stresses theoretically quite safe. For, perhaps, the strongest proof of the soundness of the foregoing statement, the author is indebted to his friend, J. E. Stead, F. R. S., who determined to test the points at issue on steels concerning whose highly dangerous character there could be no possible doubt. Mr. Stead accordingly made and tested at Middlesborough, a series of mild steels with ascending phosphorus up to about 0.5 per cent. Of course, to deliver such a steel as that last named for use in the construction of engine parts, could be the act only of a metallurgical madman. Mr. Stead's steels were forged from 6 in. to 2 in. square, and were practically identical in composition, except for their phosphorus contents. Their general analysis registered:

	Per cent.		Per cent.
Carbon.....	0.30	Silicon.....	0.21
Mn.....	0.40	Sulphur.....	0.058

In No. 1 steel the phosphorus was 0.041 per cent, in No. 2, 0.303 per cent, and in No. 3, 0.509 per cent.

The static tests are embodied in Table VIII.

TABLE VIII.

Steel No.	Phosphorus, per cent.	Yield point, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation, per cent on 6 in.	Reduction of area, per cent.
1	.041	20.4	33.1	23.0	52.0
2	.302	25.4	39.9	23.0	45.3
3	.509	32.0	44.0	20.0	45.3

The Wöhler tests made by Mr. Stead give the results set forth in Table IX, the stresses being + and — 15 tons per square inch, *i. e.*, a range of 30 tons.

TABLE IX.

Steel No.	Phosphorus per cent.	Reversals of stress endured.	Ratio of resistance to alternating stress.
1	.041	61,000	1.0
2	.302	167,000	2.7
3	.509	651,000	10.6

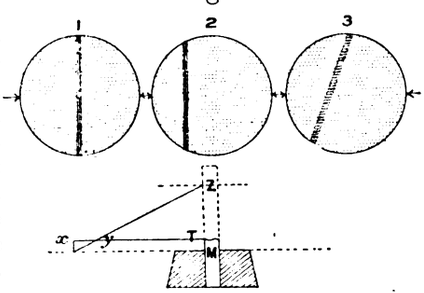
The author's tests made by him at Sheffield University in complete ignorance of the nature of the steels registered the figures embodied in Table X.

TABLE X.

Steel No.	Phosphorus, per cent.	Alternations endured in Test No. (Under standard conditions.) 1.	2.	Mean.	Ratio of resistance to alternating stress.
1	.041	258	284	272	100
2	.302	188	212	200	
3	.509	72	128	100	37

Speaking in round numbers, the Wöhler test indicated that a mild steel containing 0.5 per cent phosphorus was, with equal stresses, 10 times as capable of resisting alternating stress as a steel containing 0.04 per cent phosphorus. The author's test, on the other hand, indicated that a steel containing 0.5 per cent phosphorus had about one-third the endurance of a steel containing only 0.04 phosphorus. The curves of the yield points of the two alternating tests of the three steels are plotted in Fig. 10, where it will be seen that the Wöhler curve is sim-

Fig. 9.



ilar in type to that registered by the yield point or apparent elastic limit, the author's curve being in an opposite direction and indicating what is well known to be the mechanical effect of phosphorus on steel.

THE WÖHLER TEST APPLIED TO COPPER ALUMINUM ALLOYS.

In the eighth report made to the alloys research committee of the Institution of Mechanical Engineers by Dr. H. C. H. Carpenter and C. A. Edwards, from the National Physical Laboratory, it was observed by these authors in connection with rolled bars that the added aluminum remained dissolved in the cold alloy till the copper became saturated, namely, when about 7.5 per cent of aluminum was present. The micro-structures of these alloys, up to and including the saturated alloy, all consisted of a single constituent presenting the ordinary allotrimorphic crystals of metallography, but on the addition of aluminum in excess of 7.5 per cent a new dark-etching constituent, presumably rich in aluminum, appeared, and more or less perfectly enveloped the crystals of the saturated solution in a relatively brittle cement. A set of these alloys, in which the copper contained from 0.10

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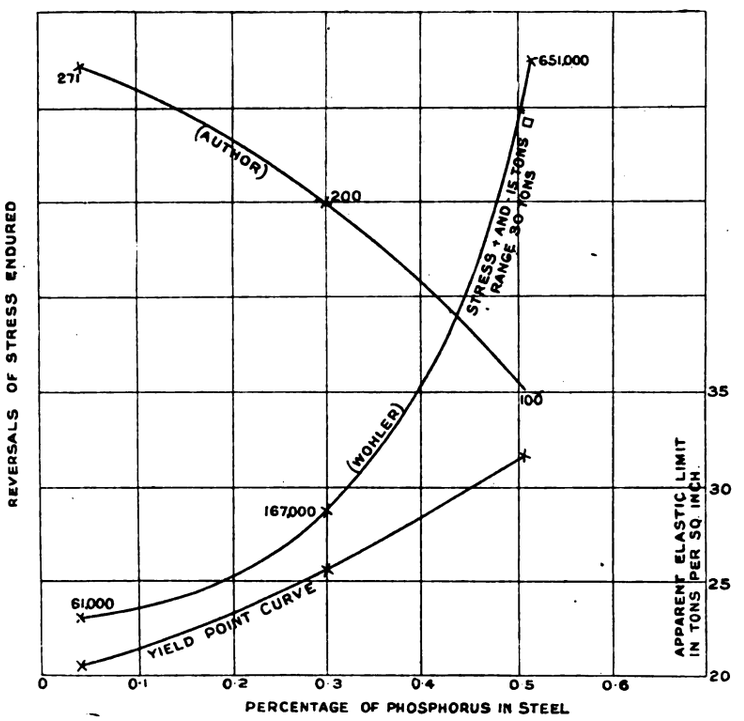
Fig. 10.

ALTERNATING TEST CURVES OF MR STEAD'S PHOSPHORIC STEELS.



to 10 per cent aluminum, was statically and kinetically tested by Dr. Stanton at the National Physical Laboratory. Dr. Stanton's machine embodies his ingenious development of that type of Wöhler test, in which the stress is evenly distributed over the whole area of the test bar. Dr. Stanton found that the alternating results were substantially a reflection of the apparent elastic limit in simple tension, namely, the endurance rose with the percentage of aluminum to about 4.5 per cent, from 4.5 per cent to about 6.5 per cent it remained fairly steady, while from 6.5 to 10 per cent the rising line of endurance became steep, reaching a maximum with the alloy containing about 90 per cent copper and 10 per cent aluminum. Thus, while somewhat faithfully reflecting the elastic limit (see curves plotted in Fig. 11), the test had entirely failed to correlate itself with a remarkable change in microstructure when the aluminum in the alloy rose from 7.5 per cent to about 10 per cent. It had been an instruction by the alloys research committee that the alloys be also tested by the author's alternating stress method in use in Sheffield University. The tests were carried out by the author in absolute ignorance of the chemical, mechanical, and micrographical features of the alloys, and the results obtained, under the standard conditions already specified, are embodied in Table XI.

TABLE XI.

N. P. L. mark.	Al per cent.	Alternations endured in Test No. 1.	Alternations endured in Test No. 2.	Mean alternations endured.
29 R	0.10	308	266	287
25 R	2.99	330	334	332
23 R	5.07	658	606	632
20 R	7.35	1,530	1,260	1,395*
18 R	9.90	707	607	657

*This alloy registered the highest resistance to alternating stresses ever observed by the author.

The mean results are plotted in Fig. 12 (Plate II), in which the upper micrograph shows the structure of the 7.38 per cent alloy and the lower micrographic features of the 9.9 per cent alloy. The author's test has sharply correlated its results with the striking structural changes in the alloys, and also shows by means of a sweetly flowing curve how the resistance to alternating stresses rises with the amount of aluminum dissolved in the copper, and reaches a maximum coincident with the saturated solution.

DOES HIGH ELASTIC LIMIT NECESSARILY MAKE FOR SAFETY?

The author unhesitatingly answers the above question in the negative. It is, of course, certain that if a metal is subjected to a working stress not far removed from its elastic limit, such metal must inevitably fracture as the result of a complex final cause, of which the Wöhler phenomenon is the most important factor; but it is a great mistake to suppose that, because a steel of high elastic limit (associated with a satisfactory statical test) gives a good result under the Wöhler test, it will be, therefore, faithful in practice. It has already been shown that the obviously dangerous steels in which Mr. Stead raised the elastic limit by chemical means, namely, by the addition of highly excessive amounts of phosphorus, quite failed to indicate under the Wöhler test their inherent brittleness, which, had they gone into use, must soon have brought about their sudden fracture under alternating stress or shock, nevertheless some engineers have become so obsessed with the high elastic limit theory as to have altogether overdone it, and so stepped out of the frying pan into the fire; for instance, with reference to holding-down bolts a pernicious practice of raising the elastic limit by mechanical strain has been practiced to a considerable extent. Take as an example small bolts of ¾ in. diameter which have been hot-rolled in the ordinary way almost to size, and then cold-drawn down, say, 1/32 of an inch, to their exact diameter. The final product is a clean, smooth bar of steel of high elastic limit, capable of registering an excellent Wöhler test. This steel also makes excessively dangerous bolts. The failure of such bolts in practice has been frequently investigated by the author. For bolt steel he has specified a resistance to alternation under the standard conditions of at least 300 reversals before fracture. He recently tested some rolled and drawn bolt steel which had broken in

Fig. 11.

ALTERNATING STRESS TESTS. (STANTON)

MAXIMUM LIMIT OF RESISTANCE (FOR 1 MILLION REVERSALS OF DIRECT STRESS AT A RATE OF 800 PER MINUTE) COMPARED WITH YIELD POINT IN SIMPLE TENSION

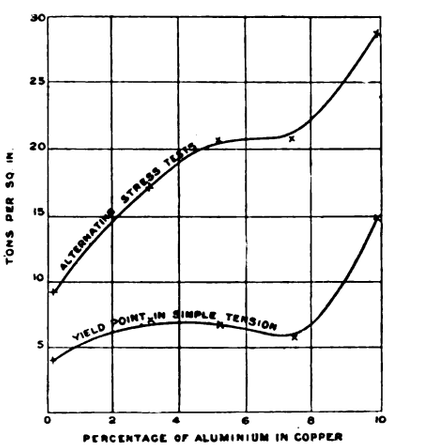


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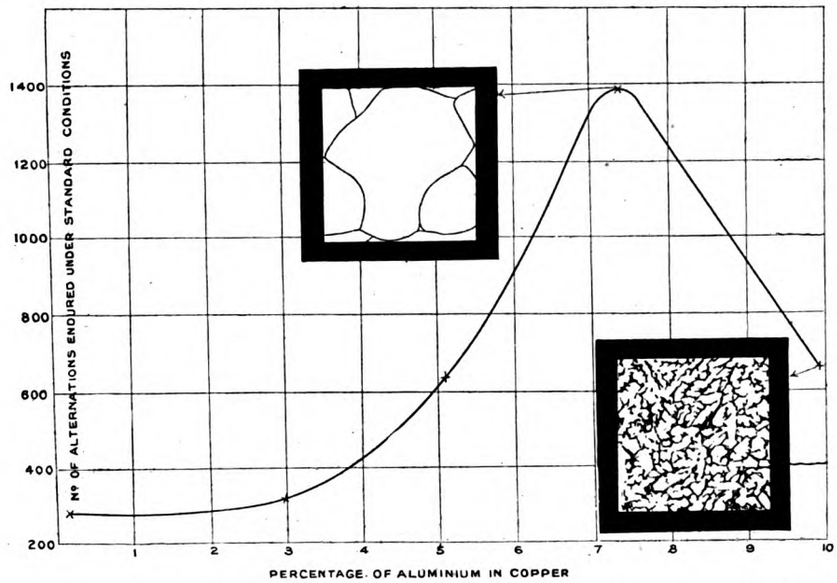
Fig. 12.

AUTHOR'S ALTERNATING STRESS CURVE OF COPPER ALUMINIUM ALLOYS



use. Its most noticeable chemical feature was an excessive percentage of phosphorus. In alternation it behaved as shown in Table XIII.

TABLE XIII.

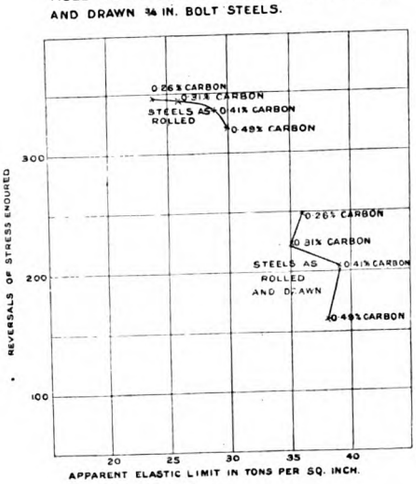
No.	Alternations endured under standard tests.	Ratio of reversals below the specification, per cent.
1	76	75
2	46	85
3	46	85
4	50	83

Some time ago, to test this question, the author made the following experiments on acid steel ¾ in. round bolts, both as rolled and in the rolled and drawn condition.

The chemical composition of the four steels employed was practically constant, except in carbon. The silicon averaged 0.12 per cent, manganese 0.85 per cent, the phosphorus 0.044 per cent, and the sulphur 0.041 per cent. The carbon contents of the "A" steel were 0.26 per cent, "B" steel 0.31 per cent, "C" steel 0.41 per cent, and the "D" steel 0.49 per cent.

Fig. 13.

AUTHOR'S STANDARD ALTERNATING STRESS AND YIELD POINT CURVES ON ROLLED AND ROLLED AND DRAWN ¾ IN. BOLT STEELS.



The tests are set forth in Table XIV.

TABLE XIV.

Mark.	C., per cent.	Yield point, tons per sq. in.	Maximum stress, tons per sq. in.	Elongation, per cent on 2 in.	Reduction of area, per cent.
HOT ROLLED SET.					
A	0.26	24.1	35.3	34.5	61.6
B	0.31	25.7	37.6	31.8	59.6
C	0.41	28.9	42.7	26.5	48.0
D	0.49	29.9	46.9	25.5	50.8
ROLLED AND DRAWN SET.					
A	0.26	36.7	38.9	19.0	50.8
B	0.31	35.1	41.9	17.5	47.2
C	0.41	38.9	46.6	16.0	40.4
D	0.49	38.0	52.4	15.0	42.0

The yield points had thus been raised by the drawing operation to the following extent:

A 12.6 tons per sq. in.
B 9.4 tons per sq. in.
C 10.0 tons per sq. in.
D 8.1 tons per sq. in.

Under the author's standard alternating tests the results embodied in Table XV were registered:

TABLE XV.

Mark.	C., per cent.	Yield point, tons per sq. in.	Alternations endured.	Condition of steel.
A	0.26	24.1	346	Hot rolled.
A	0.26	36.7	248	Rolled and drawn.
B	0.31	25.7	344	Hot rolled.
B	0.31	35.7	222	Rolled and drawn.
C	0.41	28.9	336	Hot rolled.
C	0.41	38.9	206	Rolled and drawn.
D	0.49	29.9	320	Hot rolled.
D	0.49	38.0	156	Rolled and drawn.

Thus the mean endurance of the hot-rolled steels was 337 alternations of stress, that of the rolled and drawn steel was 208 reversals, a mean difference of 129 alternations. The rolled and drawn steels were 43 per cent below the specified minimum endurance, while the hot-rolled steels were 12 per cent above the specification. It should also be remembered that the test bars were turned to ⅜ in. diameter, thus completely removing the skin of the bolts on which the mechanical injury caused by drawing would be at its maximum. The tests are plotted in Fig. 13, in which it will be seen that the erratic effect of the cold drawing has disturbed anything like regular co-ordination between the percentage of carbon present and the alternations endured. In drawing to a close his reference to the Wöhler test and its indications, the author cannot do better than quote a remarkable paragraph from an able paper on "The Production and Thermal Treatment of Steel in Large Masses," by Cosmo Johns, of Messrs. Vickers, Son & Maxim, Ltd., read before the May meeting of the Iron and Steel Institute, 1904 (Journal of the I. S. I., No. 1, page 72, 1904):

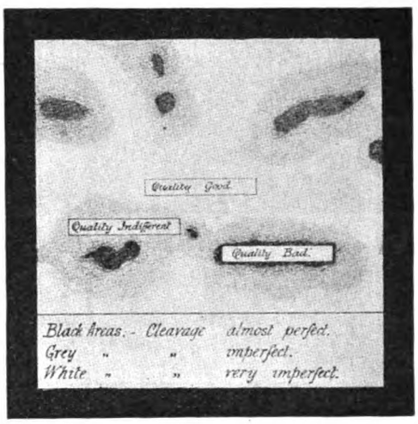


FIG. 14.

"It may have been noticed that endurance tests have not been included in the tabular results given above. The reason is that in no instance have they shown any want of agreement with the static tests, while the mere recital of the number of revolutions a particular test-piece ran before it broke, would convey no information unless they could be compared with the results obtained on other machines under similar conditions, with the same ratio of load to elastic limit. The endurance is proportional to, and depends upon, the elastic limit."

Finally, if steels were liable to fracture only under the fatigue phenomenon or Wöhler, it is hardly an unreasonable hypothesis to put forward

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that under the author's tests, steels should, within structural carbon limits, register an approximately equal endurance, since in this method all steels are stressed to about their yield

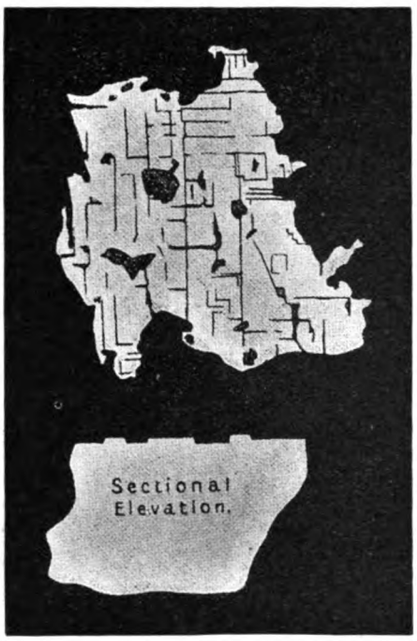


FIG. 15—CRYSTAL OF BRITTLE WROUGHT IRON.

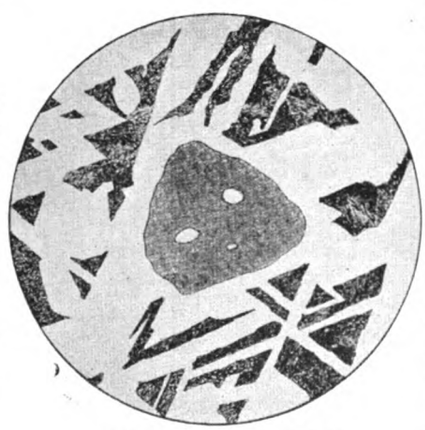
point, *i. e.*, a low carbon steel is stressed, say, to 15 tons per square inch, while a high-carbon steel would be stressed to perhaps 25 tons per square inch.

THE MOLECULAR ARCHITECTURE OF MILD STEEL.

In a report to Mr. Milton, of Lloyds Register, the author included the following paragraph:

"The facts enumerated bring metallurgists face to face with a hitherto unsuspected phase of the crystallization of iron; namely that in overheated mild steels, which necessarily leave the rolls at a high temperature, cool relatively slowly, and hence, slowly and more or less perfectly crystallize, after the microscopically visible crystallization is completed, there takes place from a series of centers a secondary and microscopically invisible phase of crystallization, which may be best described as a sharp, molecular development of potential cleavage planes. Steel in the centers of such developments will be brittle The steel near their circumferences in which the molecular rearrangement is only partially developed will be indifferent in quality, while steel beyond the radius of these developments of molecular cleavage will be good."

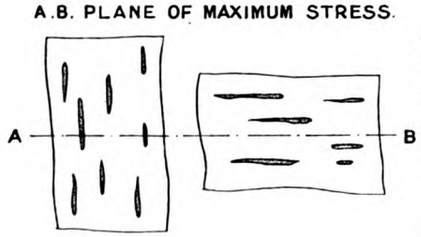
In Fig. 14 (Plate I) the hypothesis above enunciated is shown in graphic form. The theory is at any rate not antagonistic to the facts mechanically observed in boiler plates, namely, that a good area will, under the author's standard test, endure in alternation about 340 reversals, an indifferent area, say, 180 reversals, while a very bad area may endure only 60 reversals before complete fracture. Since enunciating the cleavage plane theory the author has been fortunately able to prove experimentally that a crystal of wrought iron can develop absolutely perfect mineral cleavage, parallel to the faces of the cube. Vaughan Pendred sent to him a wrought iron bolt, which, after being in use for 30 years under practically no stress, fractured



SEGREGATED AREA IN INGOT.

Fig. 16.

A.B. PLANE OF MAXIMUM STRESS.



with a few taps from a hand hammer. On microscopically examining the fractured face, a crystal was discovered showing perfect mineral "step" cleavage. This crystal is represented in Fig. 15. A piece of the broken bolt tore badly on the tension side when bent, but bent through an angle of 180° without completely fracturing. Tested in alternation under standard conditions with a piece of Farnley bolt iron for comparison, the last-named material broke after enduring 228 alternations of stress, while Mr. Pendred's bolt endured only 12 reversals, the lowest result ever registered on the author's machine in connection with structural materials.

INFLUENCE OF THE SO-CALLED "FIBER" ON THE STRENGTH OF STRUCTURAL STEEL.

The "fiber" of wrought iron is cinder. The fiber of steel is sulphide of manganese (MnS). Hence the inventor who can produce fiberless steel will deserve well of his country. Sulphide of manganese in steel was discovered in the laboratories of what is now the University of Sheffield about 1896, and on several occasions has been subsequently fully described by the author. Nevertheless, the exact effect of this constituent on the mechanical properties of steel is still imperfectly understood. Its deleterious effect in connection with ghost lines is broadly realized, but its influence on the behavior of steel with varying directions of stress is little known. It may be well to remind engineers that in steel 0.05 per cent of sulphur by weight is roughly equivalent to 0.25 per cent of sulphide of manganese by volume, a quantity by no means insignificant. This constituent permeates considerable masses of structural steel in the form of millions of little pointed rods parallel with the direction of the forging. Thus in many cases these rods (which are equivalent to fissures filled up with a fused and brittle material) are stressed at about right angles to their length, a direction in which their harmful mechanical influence is at a minimum, but there are cases in which the plane of maximum stress will be parallel to the sulphide rods or fiber, and in such cases their mechanical weakening action on the steel is at a maximum, nevertheless static tests do not indicate any very serious weakening when the plane of fracture is parallel to the fibers. The figures in Table XVI are typical of results obtained on a mild steel containing 0.04 per cent sulphur, and consequently 0.2 per cent by volume of sulphide of manganese rods.

TABLE XVI.

Direction of test.	Maximum stress tons per sq in.	Elongation per cent on 2 in.	Reduction of area. per cent.
Longitudinal	28.0	33.0	55.2
Transverse or cross.	27.2	28.0	47.7

The author, however, has found in three carefully carried out series of tests on mild steel shafts varying from 7½ to 24 in. in diameter that under rapid alternating stresses applied parallel to the direction of the sulphide rods, there is a startling difference in the capacity of the steel to resist such stresses at any rate when accompanied by a small plastic strain.

The mean results obtained are condensed into Table XVII.

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TABLE XVII.
Alternations endured under standard conditions.

Series No.	Direction of plane of maximum stress. At right angles to MnS rods.	Parallel with MnS rods.
1	283	193*
2	293	118†
3	303	117‡

*Mean of 12 tests in each direction.
†Mean of 6 tests in each direction.
‡Mean of 6 tests in each direction.

It may be remarked that all the above shafts fractured in use. The direction of the sulphide rods in relation to the plane of maximum stress on the author's machine will be clear on reference to the diagram shown in Fig. 16. The 24 fractures of the bars tested with the maximum stress plane parallel with the sulphide lines showed "fiber," which was quite absent from the 24 bars tested in the plane of maximum stress at right angle to the MnS rods.

ON POSSIBLE REMEDIAL MEASURES.

A little time ago the author submitted to Sir William White a few of the somewhat disconcerting facts described in this paper, and, while Sir William White fully agreed that it was desirable to publish them, he pointed out that a more valuable feature in such a paper would be to propose therein the steps which should be taken to prevent, as far as possible, the manufacture of steel forgings of doubtful quality, for marine and other engineering purposes. It is easy to formulate airy proposals, provided that the proposer belongs to the class by which an eminent but gloomy author has declared our island is chiefly populated. Such might take up the case with alacrity, while another abstract class of the community, although popularly supposed to be provided with wings, would strongly hesitate to step in; but, as the author is well aware that steel makers will welcome any well-considered proposals to improve the quality, especially of large masses of steel, and engineers earnestly wish to secure adequate elasticity in their materials of construction, he, with much diffidence, will venture on a few suggestive remarks in the direction indicated by Sir William White.

Remarks on Ingots.—The necessity of rejecting a sufficient weight of the upper part of a large ingot to insure the absence in the steel used for forging of liquated regions, pipes, and pockets, is too well known to need any remark, but even in the lower portions of such an ingot, presumably of good steel, it is practically impossible with a mean sulphur and phosphorus of 0.04 to 0.05 per cent each to avoid some segregation areas, if the ingot be allowed to cool at atmospheric pressure, hence the production of some ghost lines is inevitable; but if, as is sometimes the case, inferior steels containing up to 0.10 per cent each of sulphur and phosphorus are accepted, the mischief is greatly aggravated. In the author's opinion, in all heavily stressed engine parts the maximum phosphorus and sulphur should never exceed 0.05 per cent each. Even with low sulphur and phosphorus it is desirable to reduce segregation to a minimum, and, so far as the author's knowledge goes, the only reliable and practical way to bring about this consummation is to cool the ingot under fluid compression, as long carried out by the Whitworth process or by recent developments of the original idea devised by Harmet and by Messrs. Robinson and Rodger, of Sheffield. But nearly one-third from the top of the Whitworth ingot there is a large bright cavity or pocket full of mixed gases consisting chiefly of hydrogen and nitrogen, and in the vicinity of this pocket there is serious segregation, which is, of course, got rid of by cutting away the upper part of the ingot well below the pocket. The Whitworth ingot is exceedingly clean, this fact conducing to sound forging, and it is relatively free from segregation compared with a similar ingot allowed to cool spontaneously at atmospheric pressure. The maximum size of ingot to which the application of Whitworth fluid compression is effective is an open question.

The Harmet process of bottom pressure seems very successful in preventing segregation. The waste is much less than with the Whitworth process, although the skin is hardly so clean as that of the Whitworth ingot. Unfortunately the view expressed to the author by an experienced and competent expert is that a relatively small, say 20-ton ingot, must be regarded as the limit to which bottom fluid compression by the Harmet method can be effectively applied.

The Heat Treatment of Forgings.—In the author's view anything like a protracted cooling, especially at a low red heat, is dangerous, and likely to unduly lower the elastic limit of the steel under treatment.

Three other methods* suggest themselves:

1. When the forging operation is over, let the forging cool in air as far as possible out of drafts, and apply no further heat treatment.

2. Re-heat the forging to about 900° C., quench in oil, and finally "let down" by re-heating to a temperature between 300° and 400° C.

3. Re-crystallize the steel and remove stresses from the forging by heating to about 900° C., or at any rate above Osmond's top critical change point Ac_3, and then cool as quickly as the circumstances of the case will permit, in air; in other words, normalize the material.

In the opinion of the author method 3 is likely to give the best average results.

Mechanical Testing of Forgings.—The author regards kinetic tests as useful for experimental investigations, or occasionally desirable as an auxiliary method in cases of doubtful material. The static test must always be the main method of testing as between engineer and metallurgist, but the author most strongly advocates the abandonment of maximum stress as a base for the calculations of factors of safety. It has become urgent for the marine engineer to secure invariably an approximate measurement of the real elastic limit of the steel he uses. In connection with certain parts of machinery it is much easier to tender this advice than to show how it is to be followed under manufacturing conditions. It is, however, quite clear that all test pieces should be taken from the heat-treated forging before machining the latter, and that the portion taken for testing should be really representative of the mass of metal from which it is detached. As a base for calculations the yield point or apparent elastic limit offers the most promising features, since it is generaly connected with a decisive drop in the beam of the testing machine, and is consequently almost as easily, though not quite so accurately, determinable as the maximum stress. The latter, of course, should always be noted so as to obtain a reasonable ratio between the yield point and the maximum stress, say, from 45 to 55 per cent. It would, however, be quite futile to attempt to lay down dogmatic relations for this matter, because, steadily bearing in mind the obviously desirable end that the engineer should always have a reasonably accurate idea of the elasticity and, in special cases, of the resistance to alternating stress of the materials he fashions into such awe-inspiring forms, the points at issue must be settled on their merits by mutual and amicable arrangements between engineer and steel maker.

*The author has purposely refrained from discussing the possibility of always securing chemically an adequate elasticity by the introduction of special elements. This aspect of the subject is a very large one, but is well worthy of serious consideration and investigation.

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The author has to thank his colleague, J. H. Wreaks, for preparing the whole of the illustrations, and his laboratory engineer, J. Harrison, for assistance in perfecting the method of kinetic testing described in this paper.

BULK CARGO CARRYING VESSEL.

In the construction of vessels carrying cargo in bulk, such as coal, grain and the like, ship owners prescribe, among other conditions, the following: The filling of the cargo spaces must, as far as possible, take place automatically without any considerable stowing work, making the vessel self-trimming. Any gaps left unfilled or developing from the settling or

Fig. 1.

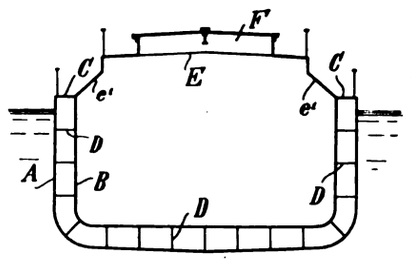
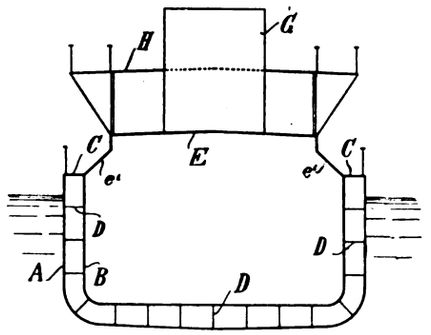


Fig. 2.



jolting together of the cargo must be such that they can fill automatically from the material in the hatches and superstructure by the movement of the vessel at sea, without interfering with the stability of the vessel. The stability of the vessel must be good, that is to say, the rolling period must not be too short, and the vessel must be capable of holding such water ballast as will ensure the propeller being completely submerged when the vessel is light.

It has been suggested to comply with the above-mentioned requirements by constructing the side walls of the holds with an angle of inclination to the horizontal plane, corresponding to the angle of rake or slope of the cargo, and by securing the water ballast through special ballast tanks on or below the deck, in addition to the customary double bottom. According to the system of measurement adopted by most nations for determining the tonnage of sea-going vessels, only the ballast space inclosed by the double walls of the hull is free of tax, while the remaining ballast spaces, such as deck tanks and side tanks, are reckoned in the measurement for tonnage and are, therefore, not exempt in the assessment of dock, harbor, canal and other dues, charges for towage, etc.

With the object of providing a freight vessel which comes up to standard requirements, and which, moreover, combines a maximum of bulk capacity and tonnage with a minimum of taxable or assessable space, a vessel, shown diagrammatically in the accompanying drawings, has been invented by Otto Mehrtens, of Kiel, Germany.

Fig. 1 is a cross section of the vessel, taken in a plane near one of the hatches, Fig. 2 being a cross section taken through or adjacent to the bridge. The vessel is provided with a double hull, A B, which is continued not only throughout the bottom, but extends up to the harbor deck C on both sides. The space between the walls A and B is adapted to receive water ballast and is divided by means of longitudinal partitions D into compartments which may communicate with one another in any suitable manner. The harbor deck is surmounted by a seaproof superstructure E, extending throughout the length of the vessel and having its side walls *e* extending upwardly directly from the inner wall B of the hull and at an angle of inclination to the horizontal plane, approximately corresponding to the rake or slope of the cargo. The side walls of the hold are free from projections or irregularities, so as to be perfectly smooth. On the superstructure are arranged hatches F, Fig. 1, and the customary projecting parts such as the smokestack G, and the bridge H, Fig. 2.

A vessel constructed according to this invention complies with the standard requirements, the self-trimming property being obtained through the arrangement of the superstructure and hatches, as also through the inclined side walls of the superstructure and the hold, while the regulation of the stability and draught is attained through the introduction of a sufficient amount of water ballast into the double hull which extends up to the harbor deck. Since the entire water ballast is placed in the double hull extending up to the harbor deck, the entire ballast space is free of assessment, according to the international system of tonnage measurement for sea-going vessels.

Besides the advantages of a low measurement, others accrue from the presence of the seaproof superstructure. According to the practice followed by classification companies (surveyors), a smaller freeboard—the perpendicular distance between the draught line and the edge of the sheer plank, amidships—is allowed in vessels having a continuous seaproof superstructure than in vessels without such a structure. A greater draught of the vessel is, therefore, permitted, and a larger loading capacity of the vessel obtained. The practice of these companies, furthermore, as far as the strength of material—plating and the like—is concerned, permits of the vessel being lighter when it has a continuous seaproof superstructure.

The firmness of the hull, it is claimed, is increased and the danger of leakage decreased by having the double hull continued clear up to the harbor deck, and, by placing the water ballast in the continuous double hull a better protection of the hull is obtained than is the case in vessels having separate water ballast tanks.

STEAMSHIP BONDS.

The Security Trust Co. of Detroit is specializing on steamship bonds, and is acting as trustee for a number of splendid issues of this security. Steamship bonds are an investment allowed the savings banks of the state of Michigan, and the issues therefor come periodically under the inspection of the bank inspectors of the state. The Security Trust Co. intends to develop this feature of its business and for that purpose has somewhat strengthened and simplified as well the form of mortgage upon which these bonds are issued. The company is at present offering an especially attractive issue at such figures to net the investors 5½ per cent. These bonds are on the steamer Howard M. Hanna Jr., recently built at the Cleveland yard of the American Ship Building Co. for the Hanna Transit Co. The Hanna is 500 ft. long, 54 ft. beam, with a gross carrying capacity of 8,500 tons. The attractiveness of this issue to the investor lies in the personnel of the Hanna Transit Co. Capt. W. C. Richardson is the president of the company and the Hanna will be managed in his office. Howard M. Hanna Jr., vice president, is associated with M. A. Hanna & Co. Among the directors are Mr. David Z. Norton, of Oglebay, Norton & Co.; Mr. J. H. Sheadle, secretary of the Cleveland-Cliffs Iron Co.; and Mr. C. C. Bolton, formerly of M. A. Hanna & Co. Other issues include the steamers Rufus P. Ranney and Caldera.

The passenger service between Cleveland and Put-in-Bay will open June 14. On Tuesdays, Thursdays, Saturdays and Sundays the steamer will leave Put-in-bay at 5 o'clock, giving passengers four hours and fifteen minutes at the bay. On Mondays, Wednesday and Fridays the steamer will leave Put-in-bay at 4 o'clock.

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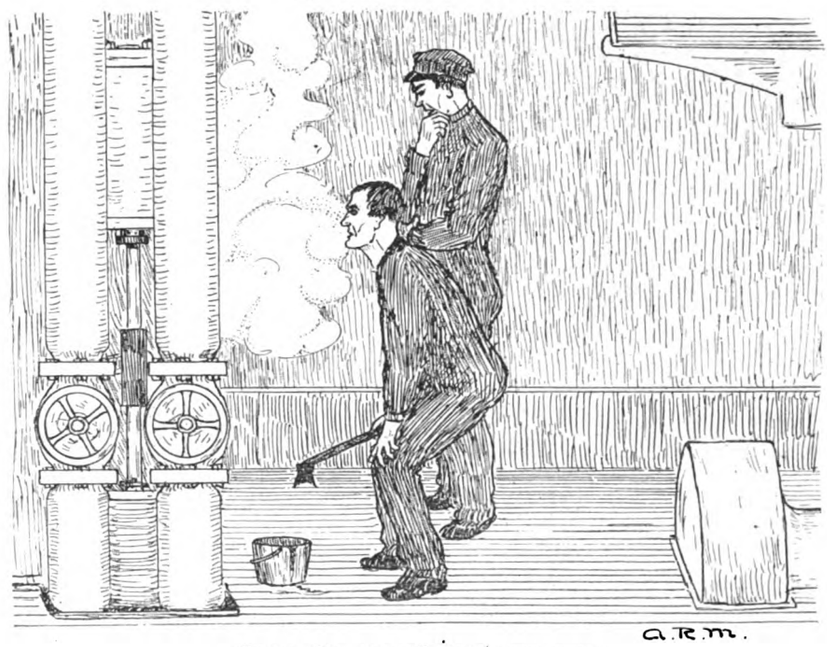
"IN THE MERCHANT SERVICE"

"It looks as though we'll have to pack that valve-stem gland," says the junior engineer to the third, for about the tenth time in the last hour of the watch.

The third looks dubiously in the direction of one of the feed pumps, the pump being more or less invisible in the clouds of vapor hovering in its vicinity, though the rythmic howl proceeding from the leaking gland makes its presence known and felt. It seems a pity to have to stop the pump just as the engines are turning up so good, and, at the same time, it is anything but a pleasant task to pack the glands after the watches are changed.



"SWAB 'ER AGAIN," SAYS THE THIRD.

"Can you nip up the gland nuts a bit?" asks the third, as he proceeds with the filling-in of the log sheet.

"Nip nothin,'" answers his disgusted subordinate, "there is nothin' to nip up." He thinks, somehow, that his superior officer's suggestions are sadly lacking in originality.

"Try swabbing her," advises the third, and his obedient assistant proceeds to borrow a swab brush and pot from the oiler on the middle platform. In a few moments, thanks to the liberal application of the brush, the howling partially subsides, and the engineers on duty look relieved. If the gland is like that at eight bells, all will be well.

It is strange that no matter how much the marine engineer may love his shipmates, he always goes on duty in the belief that the man he is relieving is concealing something from him. Likewise, the engineer who has finished his four hours in the boiler rooms, hustling the men along and carrying a passable quantity of water in the gage glass, or in the engine room, getting the most he can out of the engines and nursing the auxiliaries, strongly suspects that the relieving engineer is coming down the ladders to look for trouble. Man's inhumanity to man, etc.

Eight bells arrive, and with them the relieving watch. The pump, with the usual cussedness of its kind, has again broke forth, wailing at each stroke. The third and his junior, though closely watching the actions of the fourth and *his* junior, have assumed attitudes of careless indifference. The casual observer might not notice that their range of vision does not include the feed pumps. Why should it, huh?

After a brief whispered conversation with his assistant the fourth returns to the starting platform, a sardonic smile lighting up his otherwise handsome features.

"What's the matter with the cuckoo?" he asks blithely, adding, "is she exhausting to the atmosphere?"

"Oh, you mean that pump," responds the third, "she *is* blowing—a little—isn't she? See what's the matter with that pump." This latter remark is addressed to his junior, who wonders how he can do it. Nevertheless, he approaches the pump, the third lingering a moment to explain the pump's peculiarities.

For a few moments they glare in unison at the offending valve-stem gland, trying to hypnotize it into silence. In vain.

"Swab 'er," whispers the third hoarsely.

"I did," answers his dutiful assistant.

"Swab 'er again," says the third. He does not notice the delighted face of the fourth, who is watching their actions from the boiler room door. The junior swabs again, for a moment muffling the wailing gland. Again, in vain.

There is a brief, but fierce, argument between the third and fourth, in which the juniors take no slight interest, and it is decided to shut down the pump to pack the gland. With some considerable snarling and no little clatter the changing over of the feed pumps and shutting down are accomplished, and work commences on the gland.

"How are you making out, Smith," the fourth remarks, after watching for a few seconds the third trying to dislodge some "soft" packing—now of flint-like material—from the stuffing box.

The steam valve of the pump is leaking, and steam is hissing gently through the gland. There is also an occasional trickle of hot water descending on the fingers of the third, as he gouges into the packing with the tongue of a file. To his credit be it said that his language might be worse.

"Nearly finished?" This question from the fourth, like its predecessor, is ignored. The new soft packing absolutely refuses to enter the gland, and, having been liberally greased, is difficult to handle. The third and his assistant, each with an old file or two, narrowly escape stabbing one another occasionally as they wrestle with the pliant and slippery packing. And time is flying.

"D'ye notice that my steam's going to hell?" demands the exasperated fourth, as the third rests from his labors to drink of some cold coffee in a battered tin pail. His assistant is fanning himself with his cap as he tries to gauge the amount of coffee still in the can. The oiler, who owns the coffee, is also looking anxious. He has misjudged the capacity of his superiors.

"Well, let's get it over," says the

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third, as they attack the packing with renewed vigor. With a few minor mishaps the packing is at last home and the gland run into place. Some little delay is caused as the gland nuts have to be fished from the bilges, but at last the job is finished.

A few minutes later the third and his mate are removing some of the superfluous grime from their hands, and the third is saying, "I suppose they'll have kept some dinner for us."

"Well," said his assistant, "it's a nasty job, packing these glands, and steam on the line. Wasn't the fourth mad?"

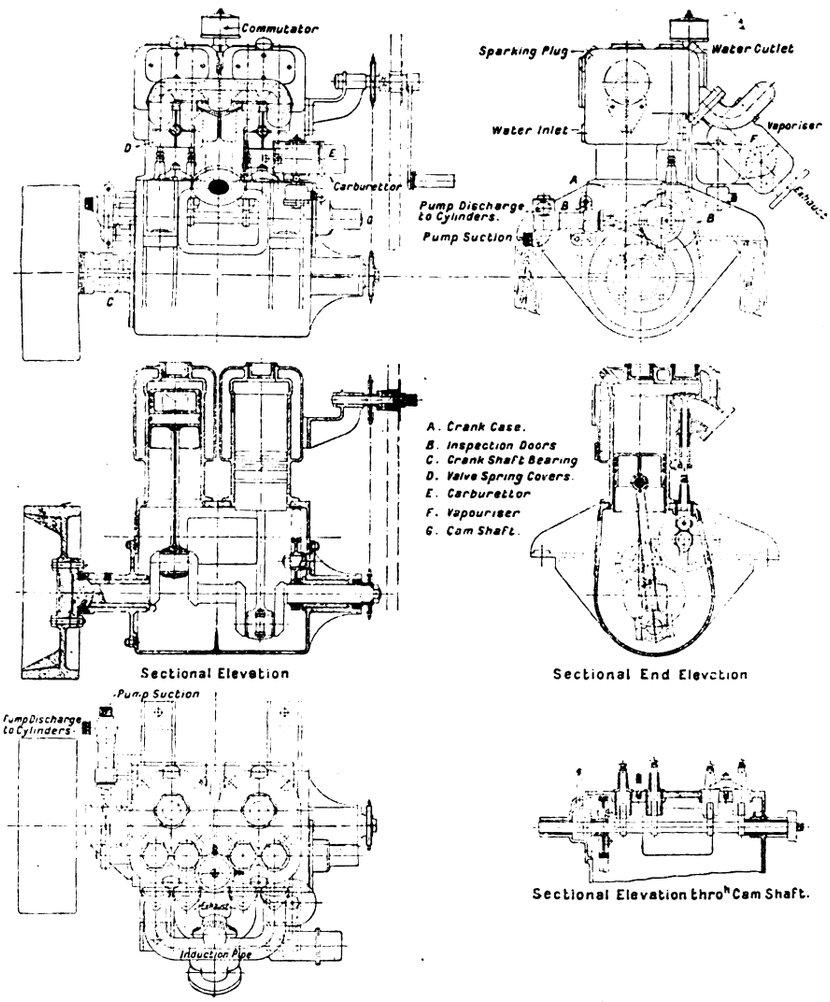
"Sure," said his superior officer, grinning for the first time that day, "as we queered his watch."

And it is all in the daily life of the steamship men; always has been, and always will be so long as steamships are steamships.

THE "STAND-BY" MAN.

A NEW MARINE INTERNAL COMBUSTION ENGINE.

We have lately received from A. B. Collis, Ltd., of Quayside Engineering Works, Bitterne Park, Southampton, a description of their latest engine for use with either paraffine or petrol. This firm has for many years been interested in the design of internal combustion engines for marine purposes only, and the present engine is the outcome of its experience in this direction. Different sizes of engines are built, ranging in horsepower from 5 to 100; but that which we illustrate in the above engraving is of 10-12 horsepower. An examination of the engraving will show that the engine is of well-proportioned design, and that it possesses several features of interest. It is of the two-cylinder type, each cylinder being cast separately. The diameter of the cylinders is 4½ in. by 5 in. stroke, and at the normal speed of running, which is 800 revolutions per minute, the designed 10 horsepower is developed. Engines of greater power than this one run normally at 600 revolutions per minute, a speed which, we believe, is now generally adopted for marine engines of fairly high power. The cylinders are spigoted into the crank case, as this construction considerably simplifies the removal of the cylinder, and does not necessitate the relining of the engine again. The valves are both placed on the same side of the cylinder, are each mechanically operated, and are interchangeable. They are worked in the customary manner by means of cams, the pusher end having a roller to prevent side thrust. One special feature of the valves, which is worthy of particular notice, is that the springs are cased in to prevent the salt atmosphere from having any detrimental effect upon them or the valve stems. The gear wheels for actuating the half-time shaft are all inside the crank case, and yet are accessible should occasion arise. In accordance with the firm's usual practice the bottom half of the crank case and the top half of the bearings are cast in one, and there are large inspection doors, one one either side of the crank case, which facilitate the removal of the crank shaft. It will be noticed that the center line of the crank shaft is in advance of the cylinder axis, in order to reduce the angularity of the connecting rod on the power stroke, and consequently the wear and tear on the cylinder walls. An ordinary plunger pump driven by an eccentric on the half-speed shaft is used for circulating the cooling water. Particularly long and serviceable bearings are provided on the crank shaft, and throughout the engine the bearings are of phosphor bronze. The thrust of the propeller is taken through ball bearings shown on each side of the crank shaft. Splash lubrication is adopted inside the crank case, a web round the bottom prevents the oil from running back when the boat begins to lift. Outside lubrication is effected either on the Stauffer system, or oil is fed from a box fitted on to the cylinder.



MARINE TYPE INTERNAL COMBUSTION ENGINE.

As stated at the commencement of the article, the engine is designed to run either on petrol or paraffine, and great attention has been paid to the mixing arrangements, to enable the same carburetor to be used with either kind of fuel. When the engine is required to work on paraffine, a vaporizer is used which is heated by the exhaust gases. When starting petrol is used until the exhaust has sufficiently heated the vaporizer to disintegrate the paraffine. This is only a matter of a few minutes.

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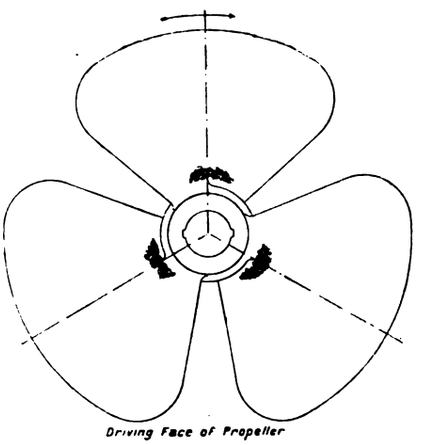
Sometimes it is particularly desirable that no petrol be carried on board, and in such cases the vaporizer is heated preliminarily by a blow-lamp. Either method is simple, but the former is to be preferred, as there need then be no delay in "getting under way." We are informed that it is the firm's usual csutom to use accumulators and a high-tension coil, but in several instances it has fitted a high-tension magneto. The commutator in the former case can be taken to the top of the engine, as is shown in the engraving, or it may be worked at the end of the half-time shaft, both methods being adopted by the firm to suit the particular requirement. It is difficult to understand why the firm has not made it the custom to fit magnetos, considering their acknowledged reliability, simplicity, and efficiency, for in our opinion ignition troubles are much more likly to occur with accumulator and coil than with a magneto machine, especially under marine conditions. In other respects considerable care appears to have been expended in the design of the different parts of the engine, all of which tend to reliability and efficiency.—*Engineer*, London.

THE PITTING OF PROPELLER BLADES.

An unexplained phenomenon of a very curious kind has occurred in some of the recently built ocean-going destroyers. These vessels are, of course, turbine driven, and the propellers are of the characteristic form suitable for high speeds. The propellers are made of bronze by different makers, and in three of the ships certainly, and possibly in others, severe pitting has occurred at the roots of the blades, as shown in accompanying sketch. The pitting is very severe, reaching a depth in some cases of as much as ¾ in., and, of course, rendering the propellers unfit for further service. The curious phenomenon exhibits itself only on the after or driven face of the blades and near the root, but the area affected measures in some cases between 40 and 50 sq. in. Discussing this subject *Engineer* of London says:

The first impression created was that this was due to some "cavitating" action set up by the interference of the propeller blades. To obtain the full value of the combination of a high-speed turbine with an essentially low-speed propeller we are compelled to compromise in many directions. In order to speed up the propeller its diameter and pitch are made small, but the final limit in reduction of size of screw is undoubtedly that of area. Mr. Barnaby indicated the principles affecting this limitation soon after the trials of H. M. S. Daring 12 years ago, and from the trials of various reciprocating-engined destroyers assigned a thrust pressure limit in relation to projected blade area—about 11 lbs. per square inch at 12-in. immersion—beyond which it was inadvisable to go. Other experimenters confirm this figure, but to get the full advantage of the rapidly revolving turbine this has been willingly exceeded, and in the case of the 33-knot boats 750 to 760 R. P. M. were only obtainable with a high thrust pressure in association with a very large ratio of projected-to-disc area, the propellers being about 6 ft. in diameter. For propellers of the type shown in the sketch the blade thickness at the root needs to be very great in proportion to the width



Driving Face of Propeller

at this point, which, incidentally, does not improve the efficiency. In view of these considerations it is impossible to avoid the feeling that the proportions were too exaggerated, and this view is partially confirmed by subsequent trials with different screws, though further pitting was observed, so that any idea of its being due only to the water pressures or to the effect of undue blade interference must be discarded. Cavitation, we had been led to believe from photographs published by C. A. Parsons, occurred on the suction or forward face of a propeller, and that its action commenced at the leading edge towards the tip of the blade; moreover, if blades are attacked at all by this action, the tip corrosion that seemed inseparable from the use of the now discarded forged steel blades on the early 27-knot boats would tend to confirm this theory. It is, of course, quite impossible to say what eddies might be set up by very fine pitched screws, with truly helical faces and sharply rounded backs, but as the pressure per square inch normally to the blades cannot have exceeded about 13 lbs. or 14 lbs. per square inch, it seems inconceivable that any eddy would create holes several inches square. The probable explanation, which was not at first accepted in view of the known excellence of the product of specialist propeller casting firms and the regularity of the phenomena in different vessels of the same type, appears to lie in the difficulty of casting solid propellers of such abnormal proportions, and not in the material used. From an analysis that we have before us of the test cuttings of one of these screws, it seems that such items as arsenic, iron, lead, tin and sulphur, which alone form doubtful elements, are only present to a total extent of 1 per cent. The copper and zinc which form the main elements have been found amply trustworthy in other propellers of similar type, and in this case there is no suspicion of the curious fatigue found to result from the vibration that caused such considerable trouble in certain foreign destroyers a few years ago.

Very finely pitched solid propellers are cast as usual with their faces down and their axes vertical, and some trouble is likely to some from dirt being washed off the mold by the action of the hot metal; but should this have been the case it is not likely to have escaped inspection. It is barely possible, in these cases, where each blade of each screw was affected, that the trouble should have ensued solely from this cause, and it is just possible that some dirt was left in and washed out by the high blade pressures, but the havoc that the loss of such a blade would cause at these extraordinarily high speeds of rotation would be so serious that the Admiralty may be trusted to enforce the strictest care in future in the manufacture of destroyer propellers. We shall look forward with interest to the possible recurrence of this trouble in the later vessels of the class before definitely adopting any one explanation. As far as is known, this is the first series of vessels in which such trouble has occurred.

HUGE TOWER CRANE FOR GERMAN SHIP BUILDING YARD.

Messrs. Bechem & Keetman, engineers, Duisburg, Germany, who make a specialty of ship yard cranes, have favored us with a photograph and particulars of the huge crane they have erected at the Vulcan ship building yard. The illustration shows one of these cranes, which consists of two main parts, i. e., a pyramidical traveling tower of square cross section and the jib, which is caried by a pyramidical steel structure in form of a hood put over the top of the tower. The trolley is running on the longer arm of the jib whilst at the end of the smaller arm the counterweight is fixed. The corner posts of the tower frame consist of angle iron and lead up in a straight line from the bottom to the top of the crane, where

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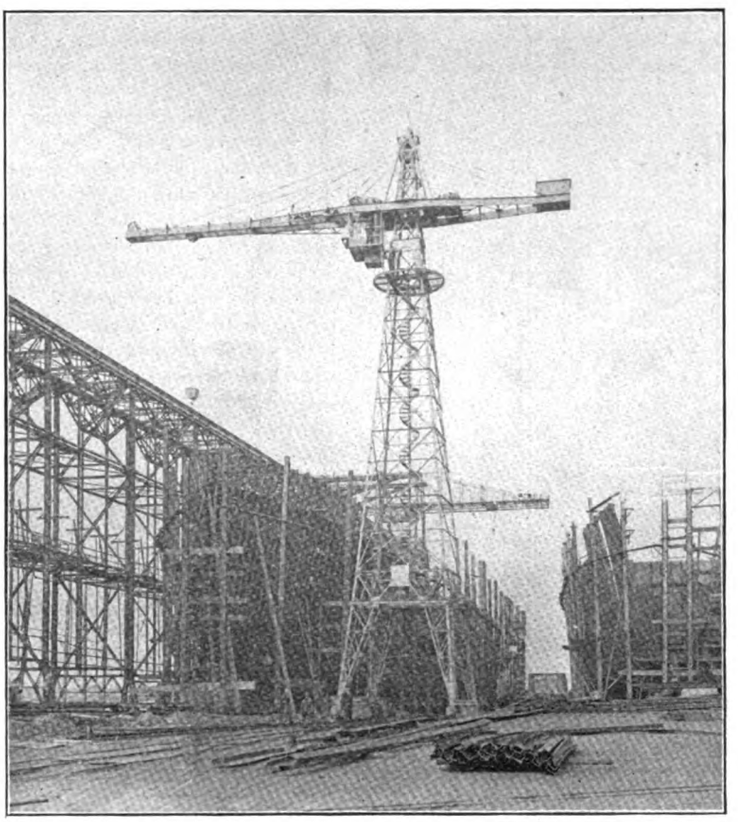
they are united by corner plates. Fastened to these plates one can see a hollow cast steel centering pivot, which form the upper collar and vertical thrust bearing for the revolving hood; the pyramidical structure is of sectional steel and strengthened by diagonals and corner plates. From the floor up to a height of 6.22 meters above the crane rails a portal has been built through which the materials can be transported alongside the ship.

The four corner posts of the tower are carried by four trucks with two truck wheels of 800 mm. each. The span of the traveling rails is 6 meters; the distance from the center to center of trucks is 8 meters.



ELECTRIC TOWER CRANE AT THE VULCAN SHIP BUILDING YARD, VEGESACK, GERMANY.

The longitudinal traveling motor is located on a platform above the portal. The power is transmitted through a horizontal shaft, bevel gears, two vertical shafts to two opposite trucks, the four wheels of which are driven.

The track has an inclination of 1:60; it was, therefore, of highest importance to equip the crane with an absolutely safe-acting brake for the longitudinal drive, because it is necessary to manipulate the crane, which has amply traveling speed with accuracy and at the same time to prevent its running away in case of wreckage.

For this purpose two independent brakes were supplied for the traveling drive, one of which is a band brake electro-magnetically operated by solenoid and weights in ordinary manner. The brake is generally loose and can be fastened by means of a directly-acting solenoid, the current of which can be shut by the operator. This second brake can also be managed by hand as well from the floor as from the operator's platform.

Aside of this arrangement the crane is equipped with rail shoes which are generally kept above the rails right in front of the upper truck wheels. Should it happen that the crane travels beyond a certain point at the end of the track these shoes fall automatically on the rails and gradually stop the crane by their friction. The shoes can also be operated at any point of the track either from the floor or from the operator's platform.

If not working the crane is fastened to the rails by means of fasteners. The stability of the whole crane is figured on a basis for wind pressures of 250 kilograms to the square meter. Between the trucks ballast boxes of 16 tons capacity are provided. The hood of the jib which rests on the pivot on the tower is also of square pyramidical steel shape and made of light frame work. At its basis are two pairs of diametral opposite rollers, which take up the load pressure in the direction of the jib. The rollers are running on a cast steel ring which is screwed to the tower. The horizontal wind pressure on the jib is transmitted to the tower frame by two single guiding rollers. The trolley runs on the lower flanges between two girders of box section, which are of the least possible height. Along the entire jib a footway of perforated sheet iron with hand railings is running, which stiffens the jib horizontally. In order to reduce the bending moment in the jib produced by the trolley, same is supported by rods fastened at the top of the hood. The operator's cab is close to the tower below the trolley tracks which is entirely enclosed and all the movements are effected from here. The above-mentioned steel castings ring is toothed and in it meshes the last pinion of the revolving drive. The latter is built up on the short arm of the jib and is easily accessible. It consists of the motor, a worm and spur gearing and the above-mentioned cast steel ring.

The coupling which connects the shaft to the worm serves as brake wheel for the electro-magnetic shoe brake. The overloading of the motor and the gearing is prevented by a friction coupling built together with the worm gear.

In order to reduce the weight and dimensions of the trolley as much as possible the lifting and trolley traveling (devices) drives are erected on the jib and right over the hood and not on the trolley itself. The trolley is moved by an endless rope, the rope drum is driven by means of a worm gearing. An electro-magnetic shoe brake holds the trolley in position. The position of the trolley and the allowable load at the proper distance from the center of the crane can be ascertained by the operator on a dial which is connected with the trolley traveling drive.

The load is suspended on four strands of steel wire rope 16 mm. θ, two strands are simultaneously wound on the drum. The lifting gearing consists exclusively of spur gearings with machine cut teeth; a pair of change gears permit the doubling of the speed when lifting smaller loads. The load is held in suspense by an electro-magnetic band brake. The controller of the lifting motor is so arranged that the motor serves as a brake, when lowering the load.

The rope sheaves of the hook block as well as the sheaves on the trolley are of ample diameter. In order to prevent the twisting of the wire ropes, the distance of same is rather large and besides the rope consists of two strands of opposite twisted wires. The main supply wires for the electric current are led in a pit along the track of the crane, the current is taken up by roller contacts from the bare wires and is transmitted by a cable through the hollow center pivot of the tower and through contact rings of ordinary construction to the operator's cab.

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The above crane has the following motors and speeds:

Lifting—Load of six tons, 20 meters per minute, 40 P. S. Load of three tons, 40 meters per minute, 40 P. S.

Crane traveling—Load of six tons, 15 meters per minute, 6, 8 P. S.

Revolving—Radius of 16 meters, 70 meters per minute, 11, 5 P. S.

Crane traveling—Sixty meters per minute, 60 P. S.

Largest outreach—For six-ton load, nine meters.

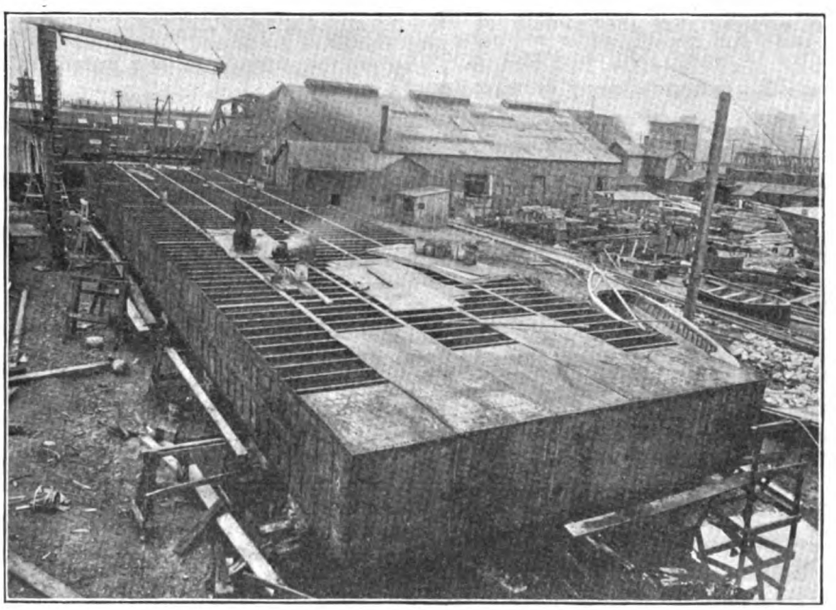
Largest outreach—For three-ton load, 16 meters.

Largest height of the hook from floor, 27 meters.

Height from the lower flanges of the jib to the floor, 27, 94 m.

DRILL BOAT FOR BUFFALO DREDGING CO.

The accompanying photograph shows the new drill boat being built for the Buffalo Dredging Co. by the Empire Ship Building Co., Buffalo, in process of construction and after 22 days' work had been done upon it. It will be ready for launching about June 11. A deck house, 114 x 27 x 13 ft. and five drill frames are being added. The boat will be 140 ft. over all, 32 ft. beam and 6 ft. 6 in. deep. Two spuds will be carried at each end, to be operated by a new design of vertical spud lifting engine. A firebox boiler 12 by 8 ft., will be installed for operating the machinery. The boat is to be used in the Detroit river.



DRILL BOAT FOR THE BUFFALO DREDGING CO., BUILDING AT THE YARD OF THE EMPIRE SHIP BUILDING CO.

LONDON FIXES SHIPPING RATE.

In a letter Congressman Humphrey, of Washington, charges that the rate to be paid for American grown wheat and other grains from Puget Sound to Europe is fixed by representatives of the Sailing Ship Association in London. He says:

"In my speech this year and also last year in congress upon the merchant marine, I called attention to the trust that exists upon the Pacific ocean formed by the sailing ships of England, Germany and France, this trust being known as the Sailing Ship Owners' International Union. I also called attention to the fact that almost immediately after this union was organized, it raised freight rates on the Pacific in most instances more than 400 per cent. It increased the freight on a ton of wheat from Seattle to Europe from $1.25 to $5.62 per ton. This trust makes no attempt to conceal its purposes.

"The inclosed shows the latest proclamation by this combine. In its rules it provides that any ship belonging to the combine that carries freight from an American port for less than the minimum price fixed by the trust shall be fined five shillings per ton on the dead weight capacity of the vessel. This union represents 1,300,000 tons, or practically all the sail tonnage on the Pacific ocean. Certainly no further evidence is needed to demonstrate that when foreign ships control our trade they fix the price to suit themselves, and that it would be a paying business investment, leaving out all other considerations, for this nation to pay a subsidy sufficient to have at least American vessels enough to compete with the foreign vessels.

"Since the formation of this trust the steamers on the Atlantic, where they almost completely control the trade, have formed a combination of similar character. This is especially true between this country and South America, where the foreign steamers by combination charge the American shipper twice the freight upon the same quality and character of goods that they charge the European merchant. The freight rates between this country and South America are the highest in the world, and there is no justification for this. It is brought about entirely by the combination of these foreign ships against American merchants."

The inclosure was a clipping from the *Phoenix*, of London, giving a report of a meeting of the union at which the freight rates on the west coasts of South and North America, Australia and New Caledonia were fixed.

AWARDS FOR MARINE SAFETY DEVICES.

Announcement was recently made of the awards in connection with the exposition conducted under the auspices of the American Museum of Safety Devices and Industrial Hygiene at its headquarters in Thirty-ninth street, New York. The gold medal for the most meritorious invention in transportation, offered by the *Scientific American*, was awarded to the Rich Marine Fire Detecting and Extinguishing System Co., for their apparatus. Honorable mention was given the exhibit of the Welin Quadrant Davit.

Chief Engineer Strale, of the Inland Steel Co., reports that there are a number of sandy shoals in the approach to Indian harbor which have depths of from 15 ft. to 19 ft. over them and which are not shown in the charts. Until a new survey is made of this locality, mariners should use caution in approaching the harbor. It is the intention of the company, in the near future, to establish a light at the head of the north pier. Further notice will be given when this light is exhibited.

The armored cruiser South Dakota on her trial trip on the Pacific averaged 22.36 knots under forced draft for four hours and 20.07 knots under natural draft. She made 0.36 knot in excess of contract requirements.

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THE MARINE REVIEW

DEVOTED TO EVERYTHING AND EVERY INTEREST CONNECTED OR ASSOCIATED WITH MARINE MATTERS ON THE FACE OF THE EARTH.

Published every Thursday by

The Penton Publishing Co.

CLEVELAND.

BOSTON.....1053 Exchange Bldg.
BUFFALO.....932 Ellicott Sq.
CHICAGO.....1328 Monadnock Blk.
CINCINNATI.....First National Bank Bldg.
NEW YORK.....1005 West Street Bldg.
PITTSBURG.....510 Park Bldg.
DULUTH.....411 Providence Bldg.

Correspondence on Marine Engineering, Ship Building and Shipping Subjects Solicited.

Subscription, U. S. and Mexico, $3.00 per annum. Canada, $4.00. Foreign, $4.50. Subscribers can have addresses changed at will.

Change of advertising copy must reach this office on Thursday preceding date of publication.

The Cleveland News Co. will supply the trade with the MARINE REVIEW through the regular channels of the American News Co.

European Agents, The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Entered at the Post Office at Cleveland, Ohio, as Second Class Matter.

June 4, 1908.

CUNARD LINE GETS SUBSIDY.

Cable announcements from London are to the effect that the British government has allowed an increase of $750,000 to the Cunard line subsidy upon the performance of the turbine steamers Lusitania and Mauretania. This makes the total subsidy now paid to the Cunard line $1,100,000 per annum. This generous subsidy is in addition to a loan of $13,000,000 at 2¾ per cent made to the Cunard line to build these two steamers.

In the face of such a concrete example as this the opposition of the American congress to the recent reasonable ocean mail bill is quite surprising. The leader among the Republicans opposing this measure was T. E. Burton, of Cleveland. Among the statements in opposition to the measure made by Mr. Burton was the following:

"There is at present a Japanese line from Puget Sound at a cost of $333,000 per year. The proposed line under the American flag would cost $777,000. There is a line from Frisco to the orient on which the payments are $500,000 a year. The cost of the proposed American line would be $932,000 to Manila."

Figures are Mr. Burton's fort and when he deals with statistics his work has great authority. He however, as was very clearly pointed out by Congressman Humphrey, erred greatly in the statement quoted. The figures that he quoted and the comparison that he made was between Japanese lines of three vessels and proposed American lines of six vessels; of Japanese vessels making a trip once a month and American vessels making a trip twice a month; between Japanese vessels running 12,000 miles and American vessels running more than 13,000 miles. In his statement he doubles the amount of pay that the American vessels would receive and cuts in two the services that they would be required to render. On the Puget Sound route his exaggeration is even greater. There he compares the pay that would be received by six American vessels of 16 knots speed with that of three Japanese vessels of 14 knots speed. He compares the total amount that will be received by six second class American vessels running upon a 13,000-mile voyage making 26 trips with the pay received by third class Japanese vessels running upon a 12,000-mile voyage making 13 trips.

TALKS ON CIRCULATION.—II.

It has been stated that circulation in boilers is either natural or artificial; that, when natural, the water is carried over the heating surfaces in regular sequences; when artificial, it is forced in contact with the heating surfaces by pumps, or their equivalent.

NATURAL CIRCULATION.

To be effective, it is essential that circulation shall be general and automatic. To be general it must involve in continuous movement the entire body of water which the boiler contains. To be automatic the impelling cause must be the conjoint action of heat and gravity. The water must be given a cycle of travel; it requires distinct and separate paths for movement upward and downward. Its upward movement must be due to the influence of heat so applied that the water will be caused to travel over the heating surfaces, as it follows the lines of least resistance on its course to the disengaging surface and steam space, or reservoir, provided for the accumulation of steam. Its downward movement must be due to gravity; weight being the measure of gravity. A very slight difference in the temperature of water changes its weight and governs the direction of its motion.

It is the function of the heating surfaces to transfer heat from fire to water; the greatest possible quantity in the shortest possible time. An automatic system of circulation will cause the water to travel continuously over heating surfaces, made clean by its motion, under most favorable conditions for the transference of heat from the surface to the water. The movement of the current facilitates the process of evaporation, transmission to the water surface, and liberation.

When heating surfaces become foul with scale or sediment, they rapidly lose capacity to perform their duty of heat transference in full, directly reducing boiler efficiency. The frictional action of water in motion over the heating surfaces prevents incrustation, and maintains a state of cleanliness which insures the unimpeded transmission of heat units from combustion chamber to water space. Circulation and cleanliness together are important factors in favor of high efficiency, and the conservation of heat units evolved by the consumption of costly coal.

Complete circulation establishes substantially one temperature throughout the structure, and eliminates the damaging effects of irregular expansion and contraction. When widely different temperatures prevail in component parts of a boiler unit, severe and unequal stresses and strains upon metal, joints, and rivets will result, these conditions, sooner or later,

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causing leakages, stoppages, and repair bills, and greatly impair the durability of a boiler.

ARTIFICIAL CIRCULATION.

When boiler troubles occur, and are traced to their root, and found to be due to the lack of circulation, it is common practice to resort to mechanical appliances with a view to overcoming the difficulty or correcting the fault, and obtaining desired results by force. Various methods are adopted, pumps or injectors, as a rule, being set in motion. Auxiliary boilers and special pumps are sometimes employed to draw hot water from one section and force it into another where the water is cold. This operation is only practicable before pressure exists, and is only useful in that it equalizes temperature and allows all parts to expand gradually and uniformly for the time being.

Another form of transference subtracts water of low temperature from the bottom of the boiler by suction and discharges it near the water level in combination with the feed water. It is actuated by the feed pump, and is therefore inoperative when the pump is idle. The subtraction of a quantity of water permits an equal volume to gradually subside and take its place. The action is local, and too slow to be mistaken for circulation. The introduction of feed water by means of pumps or injectors is likewise local and fractional; it does not disturb water remote from the place of injection; it does not accomplish anything akin to circulation.

With due forethought the assertion is hereby ventured that actual circulation cannot be established in a boiler by means of pumps or their equivalent. Work performed by these instrumentalities does not contribute in the slightest to the evaporative efficiency of a boiler, or to the increase of its capacity. It involves expense in operation, watchful care on the part of the attendants, and does not cause the general movement of the water contents of a boiler which is essential to true circulation.

LAKE SITUATION.

Vessel owners at a meeting held in Cleveland on Monday last decided to postpone the opening of navigation of the freight steamers until June 15, and if conditions are no better then than now the opening will be delayed until July 1. Last year to July 1 the fleet moved 12,685,624 tons of ore. The movement to July 1 for the present year will cut little figure in the sum total, so that the season will start on July 1 virtually 12,000,000 tons short. The total movement last year was 42,000,000 tons, so that 30,000,000 tons or more were moved after July 1. It is expected that the movement this year will be sensibly over 20,000,000 tons and the fleet therefore can care for requirements after that date readily.

The season is the flattest that the lakes has experienced in many years. What effect the announcement of the cut in steel prices will have remains to be seen, but at present lake trade is as dead as the proverbial door nail. Shippers are operating simply sufficient vessels to meet their requirements and many of the smaller vessels of the large fleets are remaining in port. Some of the captains of smaller vessels are going as mates on the larger vessels and it is even reported that some of the barge captains may serve as wheelsmen. These facts show very plainly the concentration that the situation is undergoing.

PIG IRON SITUATION.

Important developments have been following each other closely in the iron and steel market. After a strict observance for about five months of the prices of most finished and semi-finished iron and steel products, the first break in the situation came this week with the announcement of a $4 a ton reduction in steel bars. The lapse of a few hours from this action brought forth the word that the bar iron makers had followed the lead and had cut their product $3 per ton. These price changes, particularly that of steel bars, coming so abruptly upon the heels of the meeting of the general iron and steel committee in New York two weeks ago, when the statement was given to the public that the prices then in force could be regarded as fixed and that no further sessions of the committee were believed necessary until fall, have left the trade in a somewhat bewildered state. Makers of steel bars, in explanation of their decisive action at this time, declare that the present is regarded as the favorable moment for the employment of such measures as are calculated to stimulate business. The implement manufacturers, among the largest consumers of steel bars in the country, have recently been making preliminary arrangements for coming into the market for their last half and yearly requirements, and have been demanding lower prices. The week in pig iron has been somewhat less animated than the previous several weeks. Inquiry continues good, but the furnaces are showing more independence as to seeking business at present quotations, and are enjoying an improved sentiment. Prices are firm and are displaying a tendency toward a moderate advance.

BOSTON MARINE NOTES.

Boston, June 3.—The U. S. S. Gloucester (gunboat) which under Commander Wainwright in the battle of Santiago gave such a good account of herself, has been brought around to Boston from the Portsmouth navy yard where she has been overhauled and extensively repaired. Capt. James H. Dillaway Jr. is in command of the Gloucester and this summer she will be used by the Massachusetts naval brigade for receiving sea instructions.

Steam yacht Rogue is at the works of the Fore River Ship Building Co. undergoing repairs.

The towboat Eleanor O'Riordan, owned by the contracting and dredging firm of J. P. O'Riordan Co., has been completed at the ship yard of the McCarthy Co. and is now in commission. The new boat is 60 ft. long, of 38 tons gross, and under command of Capt. Foote, formerly of the Boston Towboat Co., will engage in towing dredged material to sea.

The freight steamer Bloemfontein, which arrived May 27 from Calcutta and Colombo, established a record from Gibraltar to Boston by making the passage in 11 days and 12 hours, the fastest time ever made by a freight steamer from Gibraltar rock to this port.

A. N. Whitman, of Halifax, has gone to England to purchase a steam trawler similar to the Boston steam trawler Spray. Mr. Whitman represents the new company recently organized at Halifax to engage in the fishing business with steam trawlers. The headquarters in the winter season will be at Canso, but in the summer it will prosecute the industry at various places in the Gulf of St. Lawrence.

On the New York curb, for the stock of the Electric Boat Co. $30 per share is being asked for common and $70 per share for preferred.

The knockabout type of fishing vessel designed by Thomas F. McManus, of this city, is fast displacing the old style long bowsprit class in this vicinity. About a dozen of these craft are at present under construction in the different wooden ship yards along the north shore.

The new dry dock at the Boston navy yard is capable of docking the largest ship in the navy and when the battleship fleet arrives home from its around-the-world trip a number of the ships will come here for repairs.

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TUG FOR SOUTHERN WATERS.

The accompanying plans show an 85-ft. wooden tug boat, designed for Barnard Tucker, of Philadelphia, for service on inland southern waters, towing barges, etc. In order to carry a sufficient supply of coal, and her relatively large power on a maximum draught of 8 ft., the tug had to be built exceedingly beamy. To stand the hard service to which she will be subjected she had to be built very strong. The principal dimensions of the boat are as follows:

Length over all	85 ft.
Length between perpendiculars	77 ft.
Breadth	23 ft.
Depth molded	10 ft.
Draught maximum	8 ft.

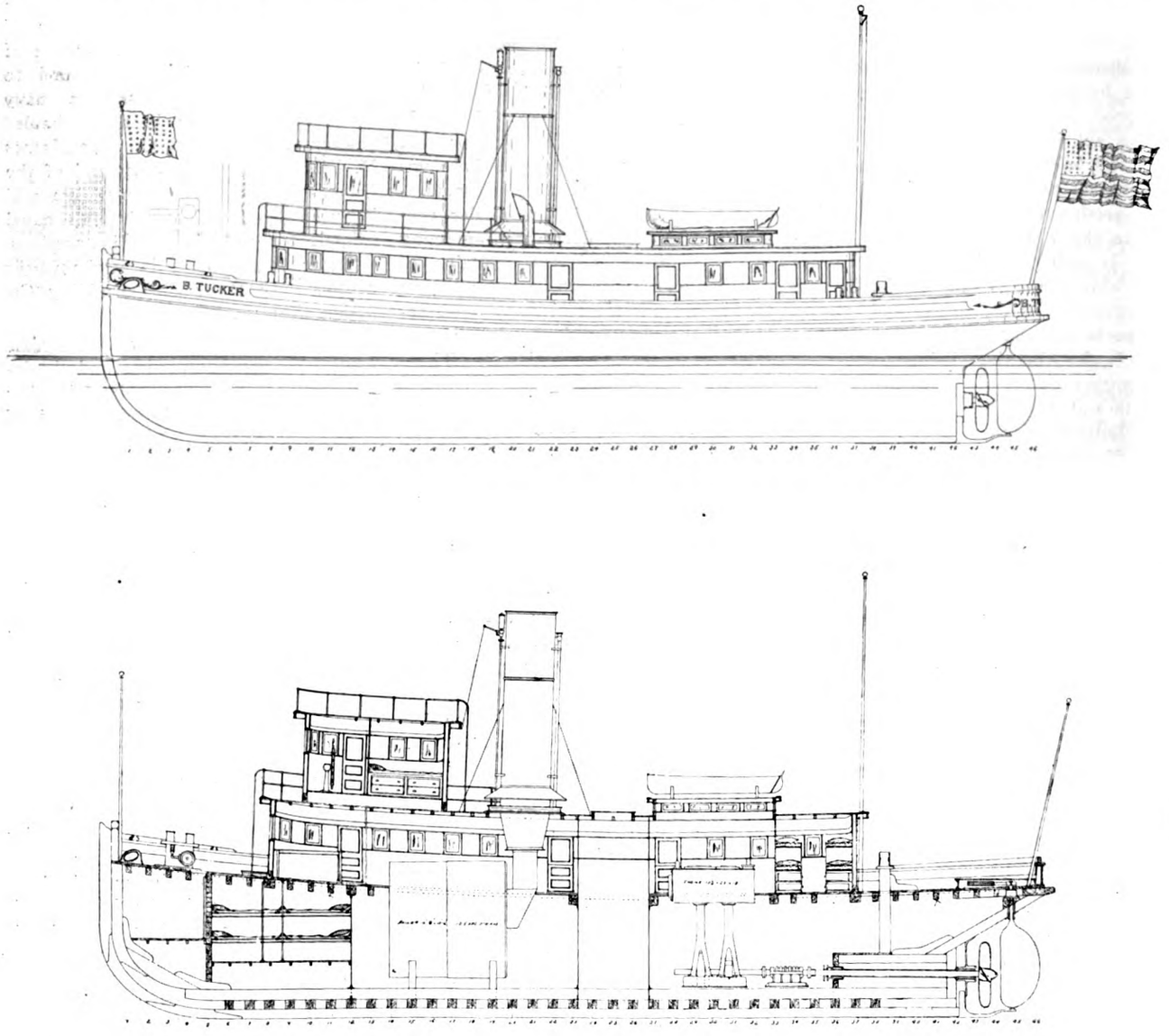
The hull will be entirely of wood, all copper fastened, the frames and timbers will be of white oak, deck beams of yellow pine, planking of white oak and yellow pine. The hull will be sheathed to 12 in. above the load line with copper. The deck and pilot houses will be of white pine.

The propelling machinery will consist of a single, vertical, fore and aft compound, surface condensing engine, having cylinders 13½ in. and 27 in. by 18-in. stroke. The high pressure cylinder will be fitted with a Meyers cut-off valve, the low pressure cylinder will be fitted with a double ported slide valve, both valves will be operated by the Stephenson double bar link motion. Both steam and hand reversing gear will be fitted. The pistons will be of cast iron, of the usual box type. They will be finished all over. The clearances in the cylinders will be ½ in. on the bottom and 3/16 in. on the top. The shafting will be of annealed open-hearth steel and will be very heavy. The bearing surfaces will be unusually large, so as to bring the surface pressures very low. The propeller shaft will be covered over its entire length with a bronze sleeve. The propeller will be of cast steel of the Philadelphia Engineering Co.'s make.

The boiler will be of the Scotch type 10 ft. 8 in. long by 10 ft. 6 in. diameter, built for a working pressure of 150 lbs. per sq. in. It will be fitted with two 42-in. corrugated furnaces.

A complete electric plant of 7 K. W. capacity will be installed. All the necessary auxiliaries will be installed.

It is estimated that the propelling engines when working at 200 revolutions per minute will develop 300 H. P.



OUTBOARD AND INBOARD PROFILE OF 85-FT. TUG, DESIGNED BY M. C. FURSTENAU, FOR SOUTHERN WATERS.

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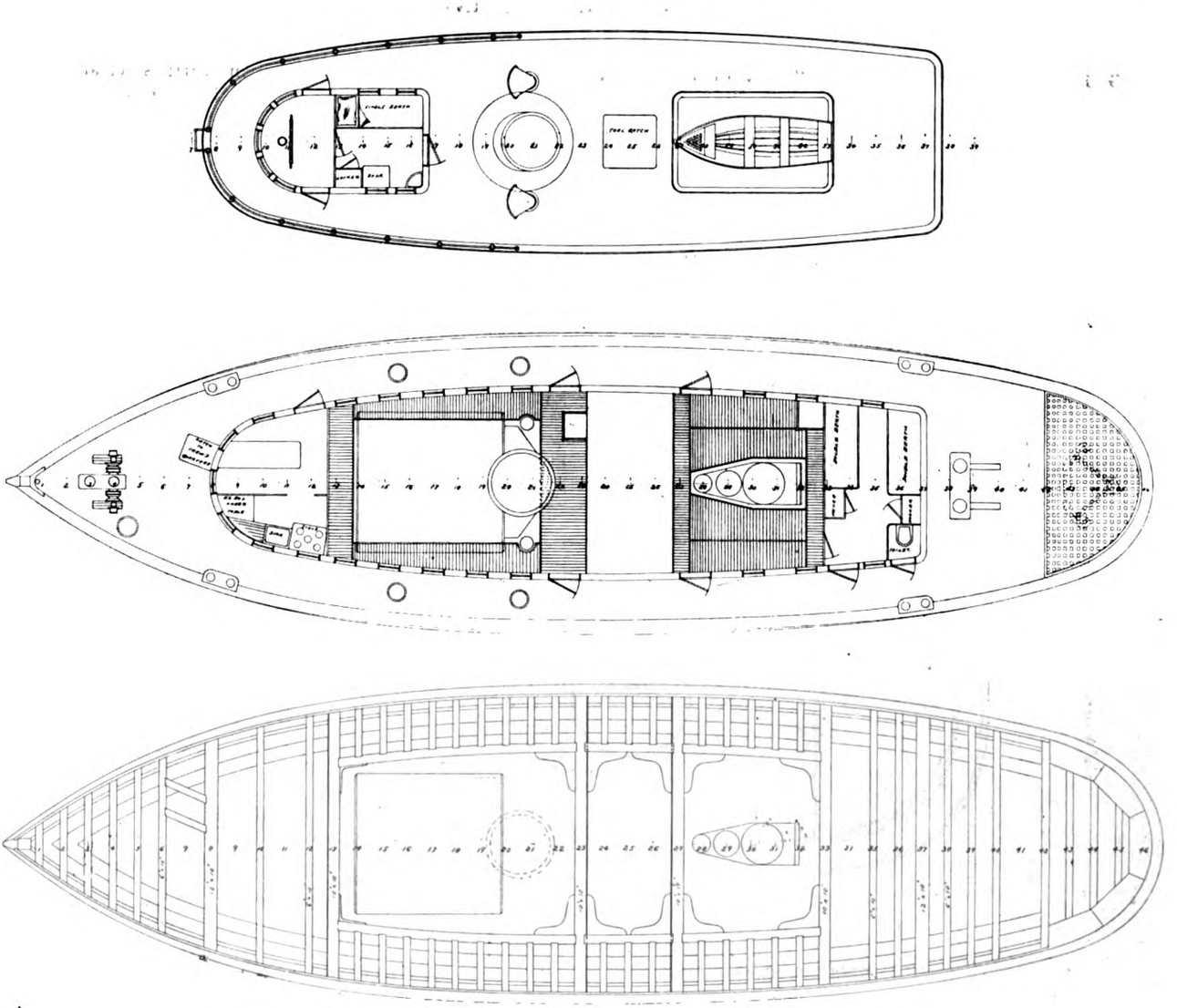

DECK PLANS OF 85-FT. TUG, DESIGNED BY M. C. FURSTENAU, FOR SOUTHERN WATERS.

The tug is to be ready for work by the spring of 1909.

The boat and machinery were designed by M. C. Furstenau, consulting marine engineer and naval architect, 308 Walnut street, Philadelphia.

ENGINEERING SECTION FRANCO-BRITISH EXHIBITION.

Messrs. John I. Thornycroft & Co., Ltd., will be showing at the Franco-British exhibition a collection of models of the torpedo craft with which their name has always been associated, as well as of other vessels, such as the customs cruiser Suriya Monthon (of which they have built a sister vessel for the Brazilian government), the shallow draught stern wheeler Livingstone, supplied for missionary service on the Congo, and one of the four launches recently delivered by them to the Spanish government (two being tenders for the royal yacht Giralda, while the others are for service with the cruiser Cataluna).

Special interest attaches to the model of H. M. S. Tartar, which is shown to ¼ in. scale, as it will be remembered this boat holds the world's record for speed at sea, having attained on its official trials no less than 35.363 knots per hour on a six hours' run on the admiralty course, while for six consecutive runs over the measured official knot the speed proved to be a mean of 35.672. When it is stated that the guaranteed speed was only 33 knots under similar conditions, and that moreover none of the other boats of the same class attained more than 34¼ knots throughout the six hours' run, the great advance made by Messrs. Thornycroft in the very important matter of speed of vessels of this type will be evident.

The model of H. M. S. Lightning, the first torpedo boat built for the British navy, in 1876, and still known in the service as No. 1, will be of interest, as a subject for contrast with the latest development of torpedo warfare. The speed of this boat was 18 knots.

As a commentary on the Tartar's record the set of photographs of torpedo vessels built by the firm during the past 20 years which held the speed records in their day is also of interest. These range from the Spanish torpedo boat Ariete, built in 1887 (which first reached 26 knots), and include H. M. S. Daring, the first of the destroyer type (built in 1893), with a speed of 28.21 knots; H. M. S. Boxer (1894) with a speed of 29.17 knots; H. M. S. Desperate, with 30.35 knots; and H. M. S. Albatross (1898), with a speed of 31½ knots. This last record was not beaten (except by the Turbinia, which was purely an experimental vessel and not fitted for service with armament and other equipment) for many years.

Another interesting model is that of the Shirakumo, one of the ten destroyers built by Messrs. Thornycroft for the Japanese government, with a

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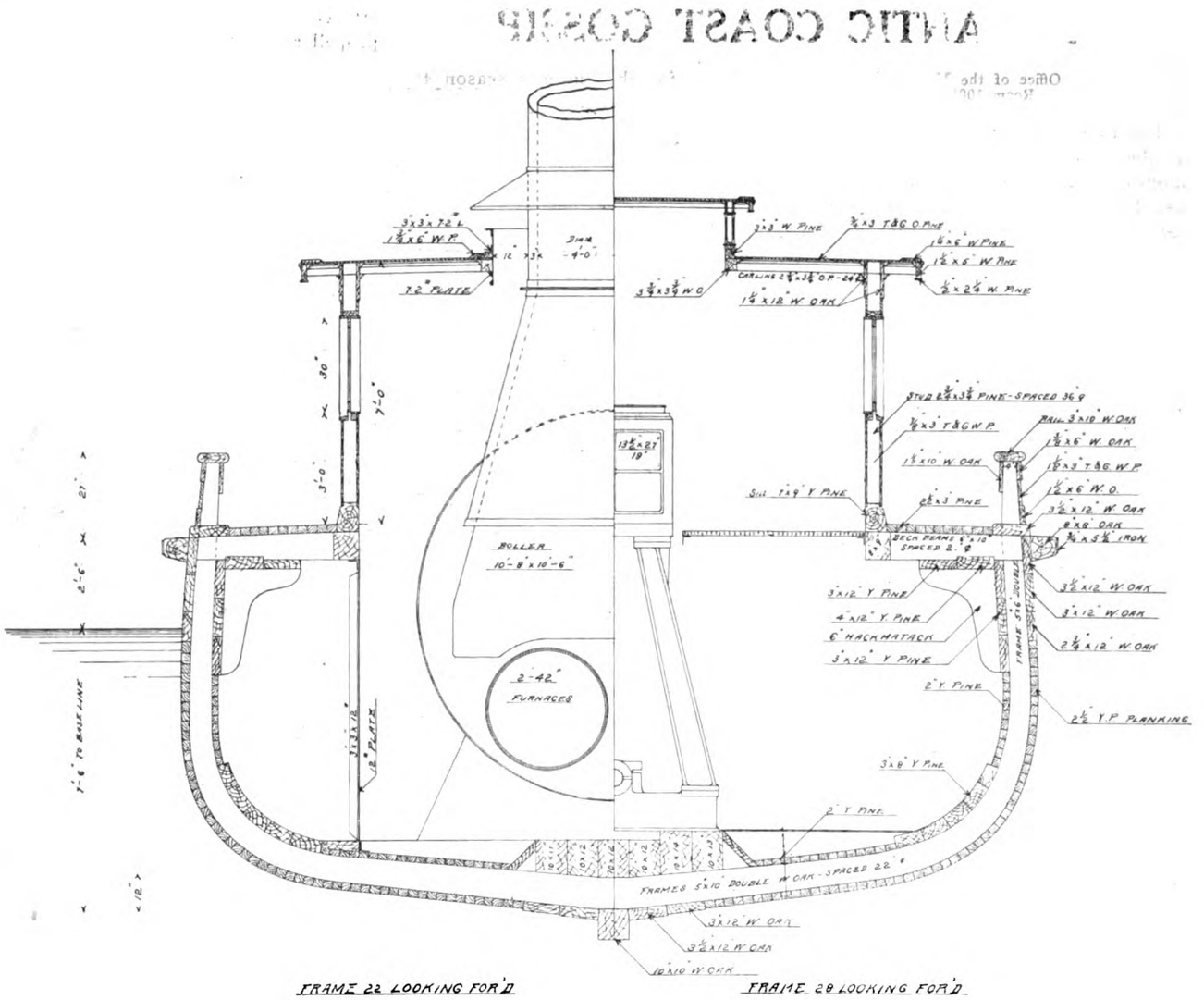

CROSS SECTION OF 85-FT. TUG, DESIGNED BY M. C. FURSTENAU, FOR SOUTHERN WATERS.

contract speed of 31 knots. Employed during the whole course of the Russo-Japanese war, the Shirakumo and its sister ships were the most efficient of the torpedo fleet which then had the opportunity of proving its great merits in a naval war. The frequent dashes into the range of fire from the vessels and forts at Port Arthur, and the subsequent good service in the various naval engagements, earned some very commendatory mentions in official dispatches and the press.

There are also illustrations of some of the numerous vessels built abroad to Messrs. Thornycroft's designs, of which those for the Italian navy amount to 28 torpedo boats and destroyers; and others illustrating Messrs. Thornycroft's many specialties, such as motor or steam tug boats, passenger vessels and launches, private yachts, motors of 700 B. H. P., pleasure cars, commercial motor vehicles, etc.

OBITUARY.

Rear Admiral A. S. Crowninshield, who was in charge of the Bureau of Navigation during the Spanish-American war, died at the Episcopal hospital at Philadelphia last week. He had been at the hospital for about a month undergoing an operation for some nasal trouble. He did not fully recover from the shock of the operation, though the immediate cause of death was due to the hardening of the tissues of the body. Admiral Crowninshield was 72 years old and had been in poor health for a long time. He was appointed to the naval academy in 1860, graduating in 1863 and serving as an ensign on the steam sloop Ticonderoga of the North Atlantic blockading squadron in 1864. He took part in both attacks on Fort Fisher. He was commissioned a lieutenant in 1866, lieutenant commander in 1868, commander in 1880 and captain in 1894. He was relieved of the command of the battleship Maine in April, 1897, by Capt. Sigsbee and that unfortunate battleship was shortly thereafter blown up in Havana harbor. Crowninshield left the Maine to become chief of the Bureau of Navigation in which capacity he served until 1901. During the war with Spain he was also a member of the Board of Naval Strategy. In April, 1902, he took command of the Eureopean station, his flagship being the battleship Ilinois. His squadron took part in the naval demonstration in English waters during the coronation of King Edward VII.

The steam yacht Shearwater has been stricken from the navy list and will be sold at auction. She was built at East Boston in 1887, and was purchased during the Spanish-American war for $26,000. For several years she was used by the Pennsylvania naval reserves, but was recently condemned and turned over to the League Island navy yard.

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ATLANTIC COAST GOSSIP

Office of the MARINE REVIEW,
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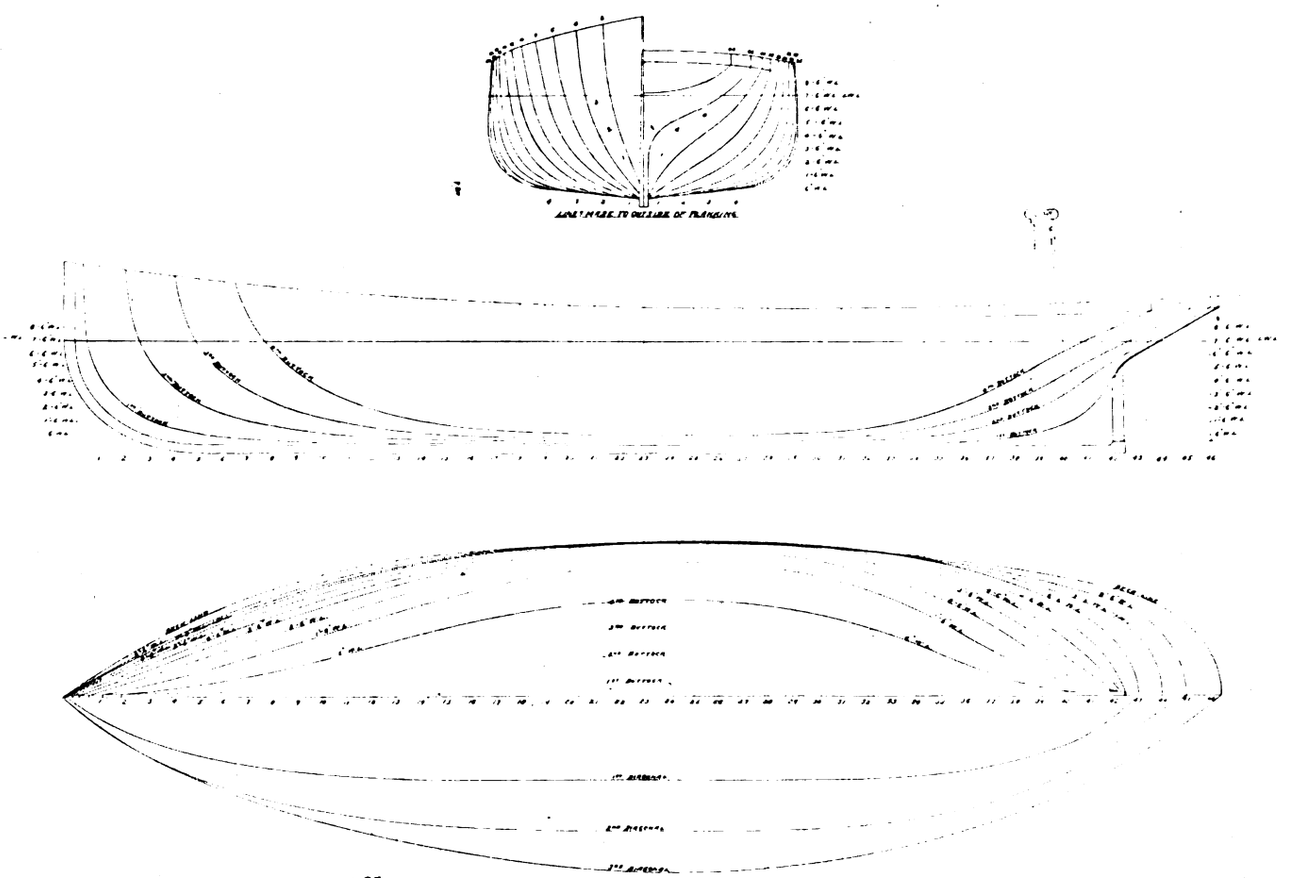
New York City.

The total number of vessels arriving at the port of New York during the month of May was 925. Of this number 434 came from foreign ports, and 491 from domestic. Of the vessels from foreign ports, 355 were steamers.



LINES FOR 85-FT. WOODEN TUG, DESIGNED BY M. C. FURSTENAU, FOR SOUTHERN WATERS.

Captain Peter Partridge, one of the oldest of the Sandy Hook pilots, died on May 30 at his home in Brooklyn. Captain Partridge was born in Longford, Ireland, in 1836, and became a pilot in 1873.

The Red Star liner Vaderland arrived at Dover on June 1, and left for New York the same day. She was somewhat delayed by a trifling accident to her machinery leaving Antwerp, anchoring in the river to make repairs.

The steamship Boothbay, of the Eastern Steamship Co., sank while lying at her wharf at Bath, Me., on Monday, having been caught under the pier at the rise of the tide and flooded. As the Boothbay had been fitted out for the summer season the accident will cause a heavy loss. There was no one aboard.

The ill-fated Peter Rickmers, ashore on the Long Island coast, has, after being cleared of her fittings and rigging by the pounding of heavy seas in addition to being partially destroyed by fire, parted amidships. It is hoped that continued fair weather will enable the wreckers to land what remains of her cargo of petroleum.

The Cunard liner Mauretania, on her arrival at Sandy Hook Tuesday evening, completed the fastest trip ever made on the westward course and broke the record for a single day's steaming. Her time between Daunt's Rock and Sandy Hook lightship was 4 days, 20 hours and 12 minutes, and her average speed for the trip 24.86 knots. At noon Sunday she had made one day's steaming of 635 miles, averaging 25.40 knots. The Lusitania's record was just three miles less than that of the Mauretania. This record-breaking trip of the Mauretania is all the more remarkable when it is considered that one of the big vessel's propellers was crippled.

The new steamship Principe di Udine, of the Lloyd Sabauda, arrived at New York this week on her maiden trip from Naples and Genoa. The Principe di Udine was built at the yards of Barclay, Curle & Co., Glasgow, for fast service, and is the first of her class sailing under the Italian flag to come to the United States. She has a displacement of 14,000 tons, and is fitted with engines of quadruple type capable of driving the vessel at a speed of almost 20 knots. There are accommodations for 350 first and second class passengers, and 1,200 steerage. She is elaborately fitted out and decorated.

The British tramp steamer Beeforth, from Pensacola, May 20, for Rotterdam, arrived at Norfolk on Sunday to coal. Two of three lifeboats had been carried away in the gale of the previous week, and she was otherwise injured. Owing to the breaking of her stanchions it became necessary to throw overboard $4,000 worth of deck cargo, two sailors being injured in the operation.

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It is rumored that an immigrant steamship service will be established between New York and Venice, to be operated by one of the larger Italian lines.

The receivers of the Metropolitan Steamship Co. have appointed George W. Apsey comptroller and general auditor, with offices at India Wharf, Boston. George W. Sterling has been appointed freight traffic manager, with offices at Pier 45, N. R., New York.

By a bill which passed congress recently, customs inspectors at the ports of New York, Philadelphia, Boston, Chicago and San Francisco, will receive an increase in pay to $6 per day. As originally introduced, increases were provided for the other grades of the service. Senate, however, amended the bill to affect the pay of the inspectors only at the ports named.

The Plant line steamship A. W. Perry, which ran aground in the Straits of Canso in a dense fog last week, was floated on Saturday. She was towed to Port Hastings to make temporary repairs, after which she will be towed to Halifax, Nova Scotia, and docked for permanent repairs.

Captain Marix, chairman of the lighthouse board, is engaged in inspecting the lights and adjuncts to navigation on the Delaware river and bay, and other parts of the fourth lighthouse district, on the tender Sunflower.

The wrecking steamer Breakwater, of Philadelphia, is engaged in raising the steam barge Nellie at Baltimore, and another barge sunk in Chesapeake Bay several weeks ago. Both of the sunken craft are owned by Capt. McQuilken, of Camden, and were bound from the Severn river for Philadelphia when they foundered.

It is understood that the government will in the near future commence blasting operations on Flood Rock, Hell Gate, where the Henry M. Whitney grounded. The main channel is to have its full width with an average depth of 26 feet at low water. Congress has appropriated $250,000 for the work, which will take two years.

The tug Reindeer, while moored in the Delaware river at Bordentown, N. J., last week, caught fire and burned to the water's edge and will be practically a total loss. The ropes securing the boat were burned through and she floated down the river a mass of flame, finally running aground. The owner is Samuel Davis, of Philadelphia.

Cablegrams state that the British steamship Craighall, from Baltimore for San Francisco, has put into Montevideo with her machinery broken down.

The White Star line proposes to place in commission a cadet ship for the training of seamen and officers for its vessels, and to that end has obtained the sailing ship Mersey. The vessel has been fitted out for this service, and will soon go into commission, the cadets and seamen to be transferred when fit to the various lines of the International Mercantile Marine Co.

In addition to millinery, tailor, bric-a-brac and other departments aboard the modern Atlantic liners, we now have fully-equipped dental parlors.

There is some talk of a cross-island canal to connect Jamaica and Flushing Bays.

Captain Salsky, of the Russian steamer Petersburg, reported, on his arrival at New York, having sighted a large school of whales between the Banks of Newfoundland and Sandy Hook. Six of the whales, which were unusually large, were sighted after the Petersburg had passed Nantucket lightship.

According to the *New York Times* a touching scene was witnessed on the pier of an out-going liner last Saturday. A man wearing a long rain coat, accompanied by a handsome woman, arrived carrying a shaggy haired yellow dog. As the pair neared the gangplank the man turned and kissing the dog on the muzzle handed it to the woman, the while addressing it:

"Now, baby, take good care of mamma, and be good to her until I come back."

Then he turned and, kissing the woman good-bye, boarded the ship.

There was no cheering.

With the departure from Mobile, Ala., of the steamship Thelma, the Mobile-Alabama steamship line went into regular service between that port and Colon on Monday. The line will handle passengers and mail, and materially reduce the time between Panama and the United States.

Passenger service by the Providence line between New York and Providence, R. I., was resumed on June 1, the steamers Plymouth and Providence taking up the running.

A passenger raft which proved to be from the steamer Larchmont, which was sunk in collision with a schooner off Watch Hill on the night of Feb. 12, 1907, has been picked up by the crew of a fishing steamer. As another life raft has been washed ashore at Block Island it is believed that the sunken steamer is breaking up.

The new steamship Chicago, of the Compagnie Generale Transatlantique, which was launched last November, sailed from Havre on Monday on her maiden trip to New York.

"PLEASE DON'T SWEAR."

Editor MARINE REVIEW:—In the REVIEW of April 2 you did me the honor of publishing a letter entitled "Navy Supervision for the Merchant Marine." Your current issue (May 28) has a note regarding the launch of the Vestal, one of the colliers therein referred to, over four years after authorization, and about 60 per cent completed at this date. I wonder if you could find space to reprint that letter, or such extracts from it as would serve the purpose, and alongside of it the advertisement for three colliers for the navy also appearing in the current issue. It is not easy to think or write patiently under such conditions. If any additional evidence condemnatory of navy methods were needed the navy itself supplies it right there. The department wants $1,550,000 to build a 6,000-ton collier, but expects to buy a ready-made 7,200-ton collier for one-third of that; confirming in every particular the statements made in that letter. But the navy will not get the boats. I predict now that when such ships are offered, if any are, there will be found so many things in which they do not conform to gold-laced, brass-buttoned, moss-grown, navy ideas, that they will be rejected. And the price is a good one, too, for a ship of that capacity. If the navy will go out and buy ships as other people do who know their business and keep their fool specifications and still more foolish inspectors off the job, they would get the ships without trouble, and they would be just as good a ship as though all the bureaus had taken a crack at them.

The Ocean Mail Act couldn't get any help from congress, but when the navy wants $125,000,000 to throw at the birds, congress can't get to a vote quick enough.

I am, sir, yours very truly,

STARBOARD WATCH.

Philadelphia, May 30, 1908.

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Lake Launchings During 1908

Between Jan. 11 and May 23 of the present year the ship builders of the great lakes have put 24 vessels into the water, all of them bulk freighters with two exceptions, one package freighter and one passenger steamer. Of this program 16 are to be credited to the American Ship Building Co., 7 to the Great Lakes Engineering Works, and one to the Toledo Ship Building Co. Of the 16 which the American Ship Building Co. launched 7 were built at the Lorain yard, making this yard in output of tonnage for that period the leading one on the lakes. The Great Lakes Engineering Works built five of its steamers at Ecorse and two at St. Clair.

This concludes new construction as far as the American Ship Building Co. is concerned, though the Great Lakes Engineering Works still has two to launch, the David B. Meacham and the Wyandotte. The Toledo Ship Building Co. has one new steamer under construction.

This table is illuminating as to the capacity of ship yards to turn out tonnage. As there is no new work in sight the various ship yards are working under greatly reduced forces, merely carrying enough to care for repairs.

LAKE LAUNCHINGS SINCE THE FIRST OF THE YEAR.

Date.	Yard.	Type.	Name.	Length Overall feet.	Carrying Capacity, gross tons.	Name and Address of Owner.
Jan. 11	Lorain	Bulk freighter	B. F. Berry	569	10,000	Fremont Steamship Co., Detroit, Mich.
Jan. 21	Ecorse	Pkg. freighter	Burlington	256	3,000	Rutland Transit Co., Buffalo, N. Y.
Jan. 25	Wyandotte	Bulk freighter	Wainwright	440	7,500	Edward Mehl, Erie, Pa.
Feb. 5	St. Clair	Bulk freighter	Normania	440	7,500	Ashtabula Steamship Co., Ashtabula, O.
Feb. 7	Ecorse	Bulk freighter	M. A. Bradley	480	8,000	Alva Steamship Co., Cleveland, O.
Feb. 8	Lorain	Bulk freighter	J. J. H. Brown	452	8,000	Brown Steamship Co., Buffalo, N. Y.
Feb. 22	Lorain	Bulk freighter	John A. McGean	440	7,500	Pioneer Steamship Co., Hutchinson & Co., Cleveland, Managers.
Feb. 22	Buffalo	Pass. steamer	Americana	215	4,000*	Lake Erie Excursion Co., Buffalo, N. Y.
Feb. 29	Cleveland	Bulk freighter	J. E. Upson	524	9,000	Wilson Transit Co., Cleveland, O.
March 21	Lorain	Bulk freighter	Wm. H. Truesdale	452	8,000	Empire Steamship Co., Buffalo, N. Y.
March 21	Ecorse	Bulk freighter	Harry A. Berwind	557	10,000	Mutual Steamship Co., Duluth, Minn., G. A. Tomlinson, Manager.
April 4	Bay City	Bulk freighter	A. W. Thompson	524	9,000	W. H. Becker, Cleveland, O.
April 4	Toledo	Bulk freighter	Fred G. Hartwell	524	9,000	Mutual Steamship Co., Duluth, Minn.
April 11	Wyandotte	Bulk freighter	A. E. Nettleton	545	10,000	Wilkinson Transportation Co., Syracuse, N. Y.
April 18	Lorain	Bulk freighter	Wm. H. Wolff	524	9,000	Gartland Steamship Co., Chicago, Ill., D. Sullivan, Manager.
April 25	Superior	Bulk freighter	Rufus P. Ranney	440	7,500	Triton Steamship Co., J. R. Davock & Co., Cleveland, Managers.
April 25	Ecorse	Bulk freighter	Wm. Livingstone	557	10,000	Mutual Steamship Co., Duluth, Minn., G. A. Tomlinson, Manager.
April 28	Cleveland	Bulk freighter	Howard M. Hanna Jr.	500	8,500	Hanna Transit Co., W. C. Richardson & Co., Cleveland, Managers.
May 2	Lorain	Bulk freighter	John A. Donaldson	400	7,000	Valley Steamship Co., W. H. Becker, Cleveland, Manager.
May 2	St. Clair	Bulk freighter	Adam E. Cornelius	440	7,500	Boland & Cornelius, Buffalo, N. Y.
May 16	Ecorse	Bulk freighter	James Corrigan	550	10,000	Frontier Steamship Co., N. Tonawanda, N. Y., W. M. Mills, Mngr.
May 16	Bay City	Bulk freighter	W. R. Woodford	552	10,000	W. A. & A. H. Hawgood, Cleveland, O.
May 23	Lorain	Bulk freighter	Price McKinney	452	8,000	J. J. Rardon, Chicago, Ill.
May 23	Superior	Bulk freighter	J. F. Durston	452	8,000	Wilkinson Transportation Co., Syracuse, N. Y.

*Passengers.

A NEW WEINLAND TURBINE CLEANER.

Weinland boiler tube cleaners are now being furnished with a new type of head which promises greater efficiency than possible with the former construction. The prominent feature of this Weinland Wing Head, as it is called, is the large number of cutter wheels swinging on crosswise arms and so mounted that the cutting wheels attack scale simultaneously in three different sections of the tube. Each arm works entirely independent of the others, so that the general effect is that of a number of cleaners all operating at once. The forward arms are provided with conical cutter wheels in front, each of which is followed by three star cutters mounted on the same shaft. The second, or rear arms contain three cutting stars each, and finish the cleaning operation by removing the last particles which may have escaped the forward wheels. It will thus be seen that as each pair of cutters revolve in a different path a large surface is being cleaned at one time and as the cleaner travels, the scale surface is successively attacked by the separate sets of cutters. Numerous tests of the new type of head prove that it works faster than the older type, and that it removes scale more thoroughly without injuring the tubes. The cone and star cutters are the only parts subject to much wear, and they may be replaced for practically nothing. The arm and pins are all hardened steel and made extra heavy, both to add strength and to give more power.

A specially compact head with universal joint is made for cleaning curved tubes and special sizes are made for each size of straight tubes. The Weinland ball and thrust bearing cleaners equipped with the Wing head are fully described in a new 36-page catalog which will be sent by the Lagonda Mfg. Co., Springfield, O., to those interested.

AROUND THE GREAT LAKES.

Arbitration apparently has not settled the collision case between the steamers Saxona and Zimmerman. The Toledo Steamship Co., owners of the Zimmerman, has served notice that it desires to withdraw from the arbitration, following a decision of W. B. Cady, of Detroit, arbitrator, that the Zimmerman was at fault in the collision and that the matter of damages was a subject of further debate between the two principals. The collision occurred in April, 1906, in St. Mary's river while the Zimmerman was on her maiden trip. Her bow was so badly crushed as to need replacement and the repair bill was a heavy one. The question at issue now will be as to whether one party may legally withdraw from a binding arbitration after decision has been rendered.

The steel schooner Doris was launched from the Dickie ship yard, Raymond, Wash., on May 21. The Doris is building for E. and E. T. Kruse, of San Francisco, and is 195 ft. long, 39 ft. beam and will carry about 800,000 ft. of lumber. The steamer Majestic, 215 ft. long, building for Ira J. Harmon, of San Francisco, will be launched from this yard next month.

The barge Montpelier, which was sunk in Detroit river last fall, has been raised by the Reid Wrecking Co., of Sarnia, and taken to Port Huron.

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Launching the Steamer James Corrigan at the Ecorse Yard of the Great Lakes Engineering Works

A STORY WITHOUT WORDS

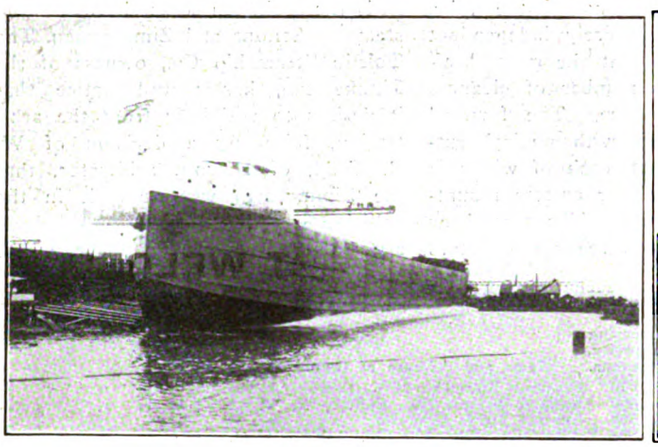

FIG. 1—THE CORRIGAN LEAVING THE WAYS.

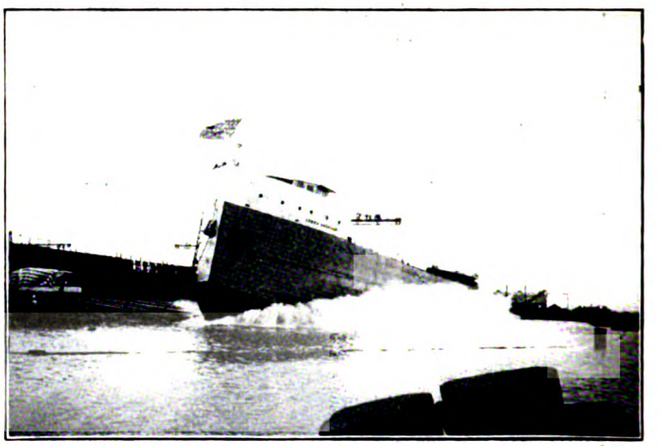

FIG. 2—THE ROLL TO PORT IMMEDIATELY THEREAFTER.

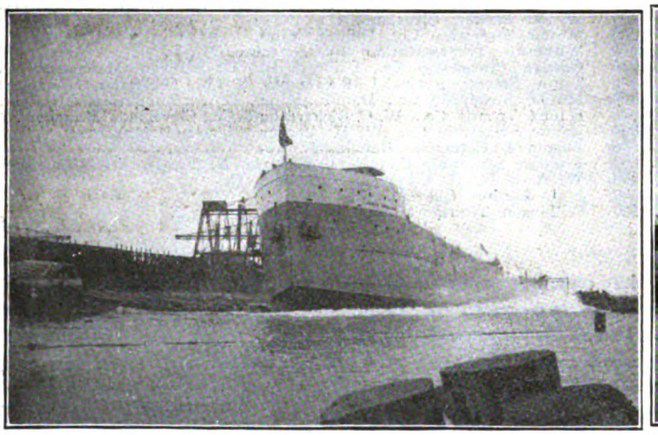

FIG. 3—THE ROLL TO STARBOARD FOLLOWING.

FIG. 4—RECOVERING FROM THE STARBOARD ROLL.

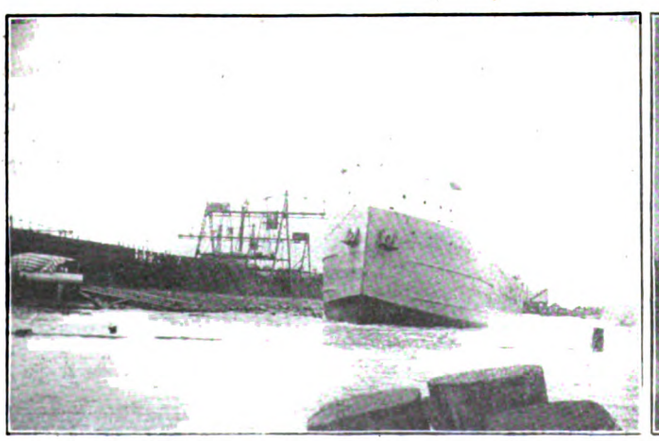

FIG. 5—THE SLIGHT LIST TO PORT THEREAFTER.

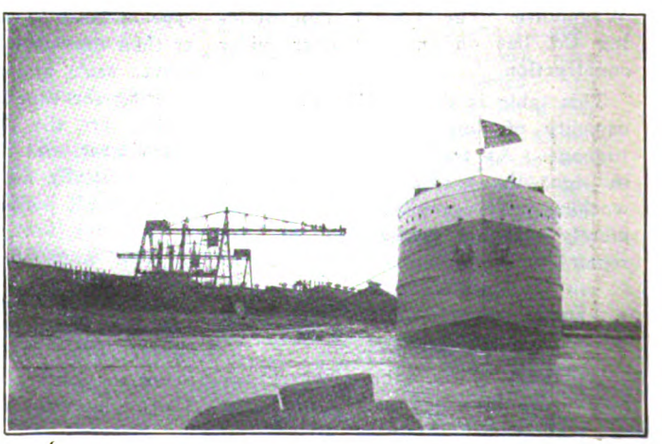

FIG. 6—ON AN EVEN KEEL.

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The Upson-Walton Co.

CLEVELAND, OHIO

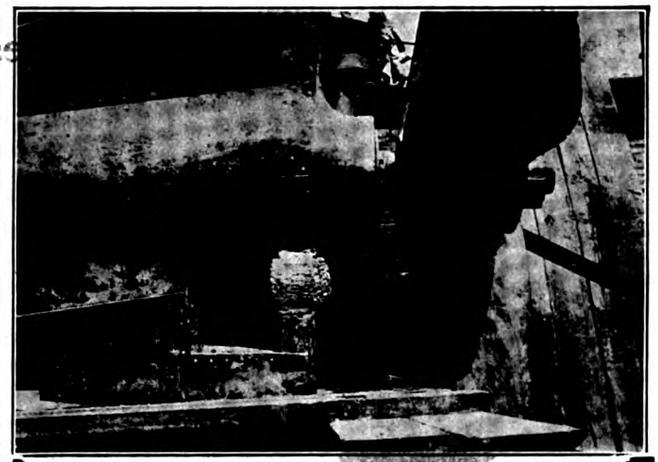
AMONG the first vessels that we fitted out was the Nellie Redington. That was nearly forty years ago, but the Nellie Redington is still afloat.

Among the latest vessels that we have fitted out is the Henry Phipps.

The Redington carries 1,500 tons; the Phipps, 12,000 tons.

As 1,500 is to 12,000 so is The Upson Walton Co. of thirty-six years ago to the Upson Walton Co. of today.

Our reputation as Outfitters of Vessels has grown year by year.



STERNPOST WELDED

Vessel In Dry Dock Only A Few Days

By the THERMIT PROCESS, welds may be made on sternposts, rudderposts, crank shafts, etc., *without dismantling or removing broken sections from ship.* Cost of dockage is very greatly reduced and repair is made in such a way as to REINFORCE the weak point, thus guarding against future breakage.
Write for Pamphlet No. 18-E and have your name placed on our mailing list to receive "REACTIONS", the thermit quarterly.

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A NEW FLAME ARC LAMP.

There has just been placed on the market by the General Electric Co., a new flame arc lamp. The external appearance of this lamp is similar to the G. I. enclosed lamp, the casing being drawn seamless from either sheet copper or steel. The standard finish for the copper casing is antique and bright japan for the steel. This lamp has no chain feed or complicated escapement and clock mechanism. It is of the inclined carbon type with nothing below the arc to obstruct the light, and both carbons feed by gravity simultaneously while the regulation of the arc is accomplished by the lateral movement of one carbon to the other. When the casing is lowered into the trimming position every part of the lamp becomes accessible.

A serviceable "economizer" of refractory material surrounds the points of the carbon just above the arc so as to prevent the washing of the carbon ends, and to steady the arc from the effect of air currents so far as possible. A "blow magnet" is so situated with relation to the arc that it performs the double function of keeping the arc steadily fan-shaped at the carbon tips, and also totally extinguishes the arc if for any reason it approaches dangerously near to the "economizer." The "economizer," therefore, is well protected from burn out and should last indefinitely. A heavy "baffle plate" of insulating material is provided just above the "economizer" effectually preventing any appreciable amount of the products of the arc from depositing on the parts of the mechanism. During operation the lower surface of the bottom plate of the lamp and of the economizer becomes coated with white deposit from the arc which acts as an excellent reflector for the upward light from the arc.

These lamps are designed to burn two-in-series or singly across 100 to 125 volt direct or alternating current circuits. They can be used on any frequency between 40 and 140 cycles. The lamps may be wound for either 8, 10 or 12 amperes, the latter current being considered standard. All lamps are equipped with light opal globes.

The life of these lamps is about 12 hours on indoor circuits and between 10 and 11 hours on outer circuits. The simple construction, remarkably high efficiency, and the volume of illumination obtained from these lamps appeal to the operators of mills, wharves, warehouses, erecting shops, foundries and other places where the quantity of light is as desirable as the quality.

A NEW VALVE.

The distinctive feature of a new valve being manufactured by the Knudsen-von Kothen Mfg. Co., Dolton, Ill., is a cast iron coil spring placed in the bonnet of the valve. By means of this spring, through which the valve stem passes, and suitable metal, bearing gaskets and sleeves a tight joint is made between the valve body and the bonnet and in addition the valve is held firmly against the seat when the stem is screwed down. The arrangement of the spring and other parts of the bonnet are shown in the cross section, Fig. 1, and it is apparent that with an unfailing tension on the spring there will be no leakage from the body of the valve up through the bonnet either of liquid or vapor. This does away with any need of packing, which is one of the special features of the valve.

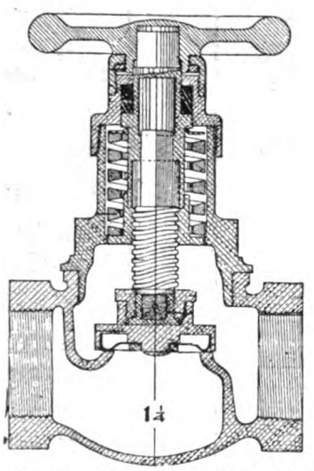

FIG. 1—A NON-LEAKING VALVE.

The cast iron spring shown in Fig. 2 is substituted for other devices because of the well-known constancy of its elasticity within certain limits of strain. The spring is so designed as to give an unfailing tension through the life of the valve. Where steel is used in springs the action of heat impairs the temper, which renders the spring valueless, with a leaky valve resulting. All the parts of the valve are nickel plated to prevent corrosion and it is offered as an absolutely non-leaking, non-packing valve for hard, continuous service.

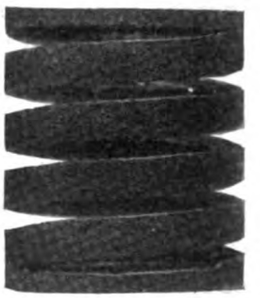

FIG. 2—CAST IRON SPRING FOR VALVE.

TRADE NOTES.

Jenkins Bros., New York, have just put out a little leaflet descriptive of their pump valves. These pump valves are made from various compounds, each of which is best adapted for some particular kind of work. Many years of experience have enabled the manufacturers to so perfect the compound and the process of manufacture that they can confidently recommend their valves as the very best obtainable. Only the best grades of rubber are used and all other ingredients are of equally high grade. When ordering, should there be any doubt as to the kind of valve required, state the service in which the valve is to be used, fluid handled and give diameter, thickness and size of hole.

The Greenwood-Atkinson-Armstrong Co., 75 Woodward avenue, Detroit, Mich., have just put out catalog No. 6, descriptive of yachting uniforms. The company is prepared to fill all orders for yachting uniforms promptly.

Jenkins Bros. have removed their Chicago store from 30-33 North Canal street to 226-228 Lake street, corner of Franklin street.

Samuel Mitchell, of Negaunee, Mich., for many years manager of the Jackson mine, the first mine to be developed in the Lake Superior region, died at Chicago recently. He was well known throughout the whole iron region.

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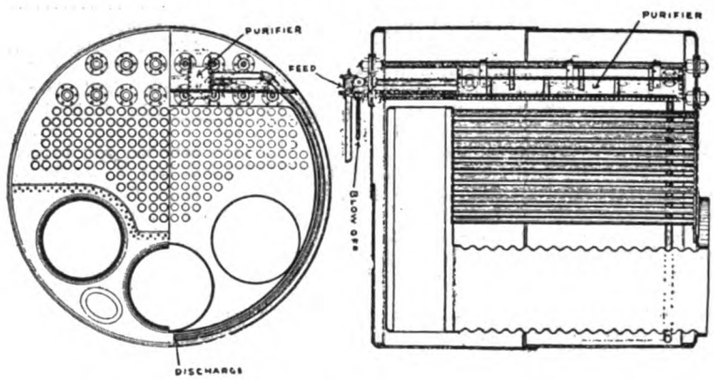
ROGERS' Combination Steam Boiler Heater, Purifier, Oil Separator and Circulating Device

permits the operation of Marine Boilers from four to six months without cleaning. It is the cheapest and easiest to operate—absolutely safe and purely mechanical. Every one installed is a complete success.

ROGERS' PATENT COMBINATION
HEATER PURIFIER OIL SEPARATOR AND CIRCULATING DEVICE



USED BY

Steamers	
Tuscarora	Hull No 75
Bethlehem	Hull No
Lighter Batavia	Hull No. 6
Gratwick	Great Lakes E. W.
Northern Star	Hull No. 31
Northern Light	Hull No. 32
Minneapolis	Hull No. 33
Huron	Hull No. 36
Abraham Stearns	Hull No. 37
Henry B Hawgood	Hugh Kennedy
Northland	No 30 at G. L. E. W.
Green	L. C. Hanna
F. C. Ball	Myron
Stafford	Buffalo (W. T. Co.)
Northwestern, N. Y.	Seneca
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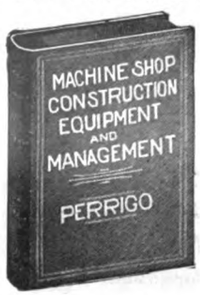

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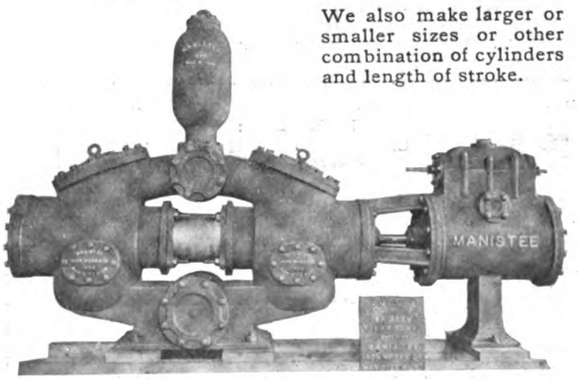

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